O

CALIFORNIA STATE MINING BUREAU
FERRY BUILDING, SAN FRANCISCO
FLETCHER HAMILTON State Mineralogist

San Francisco] BULLETIN No. 88 [July, 1920

California Mineral Production for 1919

WITH COUNTY MAPS

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO
1920

CALIFORNIA STATE MINING BUREAU
FERRY BUILDING, SAN FRANCISCO

FLETCHER HAMILTON — State Mineralogist

San Francisco] — BULLETIN No. 88 — [July, 1920

CALIFORNIA MINERAL PRODUCTION FOR 1919

WITH COUNTY MAPS

BY

WALTER W. BRADLEY

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO
1920

4548

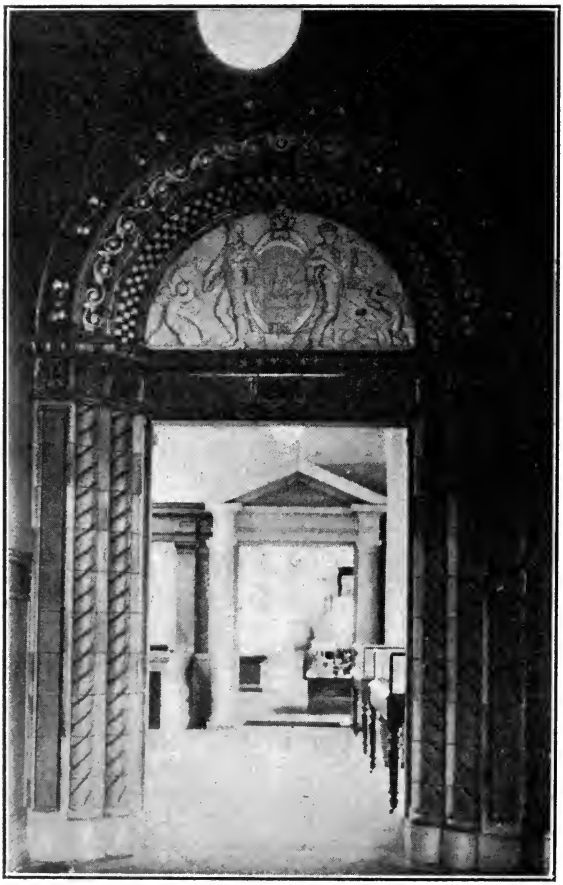


Exhibit of California structural materials in State Mining Bureau, Ferry Building, San Francisco.

CONTENTS.

ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

July, 1920.

To His Excellency, the HONORABLE WILLIAM D. STEPHENS,
Governor of the State of California.

SIR: I have the honor to herewith transmit Bulletin No. 88 of the State Mining Bureau, being the annual report of the statistics of the mineral production of California.

The remarkable variety, total valuation, and wide distribution of many of our minerals revealed herein show California's importance, both in peace and in war, as a producer of commercial minerals among the states of the Union.

Respectfully submitted.

FLETCHER HAMILTON,
State Mineralogist.

LETTER OF INTRODUCTION.

It is the endeavor of the staff of the State Mining Bureau, in these annual reports of the mineral industries of California, to so compile the statistics of production that they will be of actual use to producers and to those interested in the utilization of the mineral products of our state, while at the same time keeping the individual's data confidential. In addition to the mere figures of output, we have included descriptions of the uses and characteristics of many of the materials, as well as a brief mention of their occurrences.

The compilation of accurate and dependable figures is an extremely difficult undertaking, and the State Mineralogist takes the opportunity of here expressing his appreciation of the cooperation of the producers in making this work possible. A fuller appreciation of the value of early responses to the requests sent out in January will result in earlier completion of the manuscript. Statistics lose much of their value if their publication is unnecessarily delayed.

Some of the data relative to properties and uses of many of the minerals herein described are repeated from preceding reports, as it is intended that this annual statistical bulletin shall be somewhat of a compendium of information on California's commercial minerals and their utilization.

FLETCHER HAMILTON,
State Mineralogist.

MINERAL INDUSTRY, CALIFORNIA, 1919

DATA COMPILED FROM DIRECT RETURNS FROM PRODUCERS IN ANSWER TO INQUIRIES SENT OUT BY THE CALIFORNIA STATE MINING BUREAU, FERRY BUILDING, SAN FRANCISCO, CALIFORNIA.

CHAPTER ONE.

Mineral output in California during the year 1919 amounted to the sum of $196,473,560 worth of crude materials. There were fifty different mineral substances, exclusive of a segregation of the various stones grouped under gems; and of the fifty-eight counties of the state, all but one contributed some mineral product.

As compared with the 1918 output, the notable features of 1919 are: The continued increase in petroleum valuation, and the decrease in the so-called 'war minerals,' chromite, copper, magnesite, manganese, potash, and tungsten. Despite decreased valuation totaling over $18,000,000 shown by a number of substances, the result is a net decrease of only $3,280,277 in the grand total value, owing to the great increase by petroleum.

Of the metals: Copper decreased from 47,793,046 pounds and $11,805,883 to 22,162,605 pounds and $4,122,246; quicksilver approximately one-third in quantity and one-half in value; lead and tungsten to about one-tenth; manganese to one-half. Gold and platinum were the only metals to yield increases, and they were small proportionately.

Petroleum increased from 99,731,177 barrels and $127,459,221 to 101,182,962 barrels and $142,610,563. Natural gas also increased.

Several of the structural and industrial minerals decreased in 1919, as compared to the 1918 figures, notably: Chromite, a drop of $3,552,333 in value; magnesite, with $351,398; and limestone, $208,113, the last-named being, in part, the result of the closing down of copper smelters which use limestone for flux. Increases are noted among others, for brick and tile, 'miscellaneous stone' (crushed rock, sand and gravel), and pyrite. Of the salines, potash decreased $4,393,013 in value, with borax and soda exhibiting smaller drops.

The figures of the State Mining Bureau are made up from reports received direct from the producers of the various minerals. Care is exercised in avoiding duplication, and any error is likely to be on the side of under rather than over estimation.

California yields commercially a greater number and variety of mineral products than any other state in the United States, and probably more than any other equal area elsewhere of the earth. Previous to 1916, the total annual value of her output was surpassed by but four other states, they being the great coal and iron producers of east of the Mississippi River. In 1916 and 1917, because of their enormous increases in copper output, Montana and Arizona passed California in total value for those years; and Arizona for 1918. Of one item, at

Camp 9 Power House of Sierra and San Francisco Power Company, Tuolumne County. Photo by C. A. Logan.

least, borax, California still remains the sole producer; and for many years was also the sole domestic source of chromite and magnesite. We produce at least 75% of the quicksilver of the United States. For some years we have been leading all others in gold and platinum; while alternating in the lead with Colorado in tungsten, and with Okalahoma in petroleum.

The following table shows the comparative yield of mineral substances of California for 1918 and 1919, as compiled from the returns received at the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

Substance	1918		1919		Increase+ Decrease—
	Amount	Value	Amount	Value	Value
Asbestos	229 tons	$9,903	[1]	[1]	[1] —
Barytes	100 tons	1,500	1,501 tons	$18,065	$16,565+
Bituminous rock	2,561 tons	9,067	4,614 tons	18,537	9,470+
Borax	88,772 tons	1,867,908	66,791 tons	1,717,192	150,716—
Brick and tile		2,363,481		3,087,067	723,586+
Cadmium	[2]	[2]			—
Cement	4,772,921 bbls	7,969,909	4,645,289 bbls.	8,591,990	622,081+
Chromite	73,955 tons	3,649,497	4,314 tons	97,164	3,552,333—
Clay (pottery)	112,423 tons	166,788	135,708 tons	245,019	78,231+
Coal	6,343 tons	16,149	2,983 tons	8,203	7,946—
Copper	47,793,046 lbs.	11,805,883	22,162,665 lbs.	4,122,246	7,683,637—
Dolomite	24,560 tons	79,441	24,502 tons	67,953	11,488—
Feldspar	4,132 tons	22,061	1,272 tons	12,965	9,096—
Fluorspar	[2]	[2]			—
Fuller's earth	37 tons	333	385 tons	3,810	3,477+
Gems		650		5,425	4,775+
Gold		16,529,162		17,335,100	805,938+
Granite		139,861		220,743	80,882+
Graphite	[2]	[2]	[1]	[1]	[1] +
Gypsum	19,695 tons	37,176	19,813 tons	50,579	13,403+
Infusorial and diatomaceous earths	35,963 tons	189,459	40,200 tons	217,800	28,341+
Iron ore	3,108 tons	15,947	2,300 tons	13,796	2,151—
Lead	13,464,869 lbs.	956,006	4,139,562 lbs.	219,397	736,609—
Lime	436,843 bbls.	461,315	420,696 bbls.	552,043	90,728+
Limestone	208,563 tons	456,258	88,291 tons	248,145	208,113—
Lithia	4,111 tons	73,998	800 tons	14,400	59,598—
Magnesite	83,974 tons	803,492	44,696 tons	452,094	351,398—
Magnesium salts	1,008 tons	29,955	1,616 tons	82,457	52,502+
Manganese ore	26,075 tons	979,235	11,569 tons	451,422	527,813—
Marble	[3] 17,428 cu. ft.	49,898	25,020 cu. ft.	74,482	24,584+
Mineral paint	728 tons	4,738	1,780 tons	17,055	12,317+
Mineral water	1,808,791 gals.	375,650	2,233,842 gals.	340,117	35,533—
Molybdenum	[2]	[2]			—
Natural gas	46,373,052 M cu. ft.	3,289,524	52,173,503 M cu. ft.	4,041,217	751,693+
Petroleum	99,731,177 bbls.	127,459,221	101,182,962 bbls.	142,610,563	15,151,342+
Platinum	571 oz.	42,788	418 fine oz.	60,611	17,823+
Potash	49,381 tons	6,808,976	28,118 tons	2,415,963	4,393,013—
Pumice and volcanic ash	2,114 tons	28,639	2,388 tons	43,657	14,988+
Pyrite	128,329 tons	425,012	147,024 tons	540,300	115,288+
Quicksilver	22,621 flasks	2,579,472	15,200 flasks	1,353,381	1,226,091—
Salt	212,076 tons	806,328	233,994 tons	896,963	90,635+
Sandstone	900 cu. ft.	400	5,400 cu. ft.	3,720	3,320+
Silica (sand and quartz)	23,257 tons	88,930	18,659 tons	101,600	12,670+
Silver		1,427,861		1,244,464	183,397—
Soapstone and talc	11,760 tons	85,534	8,764 tons	115,091	29,557+
Soda	20,447 tons	855,423	21,294 tons	721,958	133,465—
Stone, miscellaneous	[4]	3,404,157		3,698,944	294,787+
Strontium	2,900 tons	33,000			33,000—
Tungsten concentrates	1,982 tons	2,832,222	214 tons	219,316	2,612,906—
Zinc	5,565,561 lbs.	506,466	1,384,192 lbs.	101,046	405,420—
Unapportioned		[2] 15,134		[1]25,903	10,769+
Totals		$199,753,837		$196,473,560	
Net decrease					$3,280,277—

[1]Unapportioned—includes asbestos and graphite.
[2]Unapportioned—includes cadmium, fluorspar, graphite and molybdenum.
[3]Includes onyx and serpentine.
[4]Includes macadam, ballast, rubble, riprap, paving blocks, sand, gravel, and grinding-mill pebbles.

The following table shows the comparative value of the mineral production of the various counties in the state, for the years 1918 and 1919:

County	1918	1919
Alameda	$1,173,535	$1,304,685
Alpine		100
Amador	3,452,640	3,439,842
Butte	873,035	803,829
Calaveras	2,794,452	1,886,608
Colusa	16,400	7,300
Contra Costa	1,324,251	1,395,558
Del Norte	371,675	6,871
El Dorado	959,286	164,452
Fresno	19,876,625	21,643,898
Glenn	89,699	59,637
Humboldt	141,954	43,667
Imperial	109,692	133,236
Inyo	5,177,676	2,674,835
Kern	63,410,685	67,153,361
Kings	9,229	51,283
Lake	215,876	39,375
Lassen	800	1,100
Los Angeles	16,006,628	23,606,381
Madera	114,327	110,683
Marin	176,183	228,974
Mariposa	352,504	410,535
Mendocino	108,388	14,214
Merced	74,849	40,350
Modoc	8,220	8,670
Mono	54,863	52,682
Monterey	119,687	148,504
Napa	1,676,367	275,303
Nevada	3,301,651	3,068,010
Orange	22,914,660	27,848,727
Placer	903,520	415,131
Plumas	3,092,694	2,183,750
Riverside	1,689,042	2,578,250
Sacramento	2,102,597	2,275,827
San Benito	1,537,463	1,276,476
San Bernardino	7,632,790	4,236,199
San Diego	1,942,150	343,230
San Francisco	16,463	65,541
San Joaquin	601,973	449,000
San Luis Obispo	858,679	212,430
San Mateo	193,812	241,671
Santa Barbara	10,051,831	7,594,917
Santa Clara	1,759,568	1,048,571
Santa Cruz	2,599,717	2,245,056
Shasta	8,098,671	2,912,718
Sierra	331,501	292,950
Siskiyou	877,287	608,468
Solano	1,470,726	1,672,084
Sonoma	586,391	286,038
Stanislaus	453,913	590,326
Sutter		
Tehama	157,591	9,000
Trinity	707,524	536,783
Tulare	527,408	331,001
Tuolumne	602,278	459,396
Ventura	2,186,311	3,017,074
Yolo	21,215	25,466
Yuba	3,844,885	3,943,537
Totals	$199,753,837	$196,473,560

Total Production.

The following tabulation gives the total value of mineral production of California by years since 1887, in which year compilation of such data by the State Mining Bureau began. At the side of these figures the writer has placed the values of the most important metal and non-metal items—gold and petroleum.

In the same period copper has also increased, beginning with 1897 following the entry of the Shasta County mines. Cement increased rapidly from 1902, while crushed rock, sand and gravel parallels the cement increase. Quicksilver has been up and down. Mineral water and salt have always been important items, but the values fluctuate. Borax has increased materially since 1896. Wartime increases, 1915-1918, were shown by chromite, copper, lead, magnesite, manganese, silver, tungsten and zinc, but all declined in 1919.

Total Mineral Production of California by Years, Since 1887.

Year	Total value of all minerals	Gold, value	Petroleum, value
1887	$19,785,868	$13,588,614	$1,357,144
1888	19,469,320	12,750,000	1,380,666
1889	16,681,731	11,212,913	368,048
1890	18,039,666	12,309,793	384,200
1891	18,872,413	12,728,869	401,264
1892	18,300,168	12,571,900	561,333
1893	18,811,261	12,422,811	608,092
1894	20,203,294	13,923,281	1,064,521
1895	22,844,663	15,334,317	1,000,235
1896	24,291,398	17,181,562	1,180,793
1897	25,142,441	15,871,401	1,918,269
1898	27,289,079	15,906,478	2,376,420
1899	29,313,460	15,336,031	2,660,793
1900	32,622,945	15,863,355	4,152,928
1901	34,355,981	16,989,044	2,961,102
1902	35,069,105	16,910,320	4,692,189
1903	37,759,040	16,471,264	7,313,271
1904	43,778,348	19,109,600	8,317,809
1905	43,069,227	19,197,043	9,007,820
1906	46,776,085	18,732,452	9,238,020
1907	55,697,949	16,727,928	16,783,943
1908	66,363,198	18,761,559	26,566,181
1909	82,972,209	20,237,870	32,398,187
1910	88,419,079	19,715,440	37,689,542
1911	87,497,879	19,738,908	40,552,088
1912	88,972,385	19,713,478	41,868,344
1913	98,644,639	20,406,958	48,578,014
1914	93,314,773	20,653,496	47,487,109
1915	96,663,369	22,442,296	43,503,837
1916	127,901,610	21,410,741	57,421,334
1917	161,202,962	20,087,504	86,976,209
1918	199,753,837	16,529,162	127,459,221
1919	196,473,560	*17,335,100	142,610,563
Totals	$996,352,942	$558,171,488	$810,839,489

*Estimated.

Dividends.

Among the metal-mine dividend payers in 1919 in California the following have been reported:*

Company	Metal	Shares issued	Par value	Paid in 1920	Total	Latest dividends	
						Date	Share
Argonaut	Gold	200,000	$5 00		$1,970,000	Dec. 25, 1919	$0.05
Atolia	Tungsten	100,000	1 00		5,264,500	Dec. 14, 1918	0.50
Cerro Gordo	Lead, Zinc, Silver	1,000,000	1 00		300,000	Jan. 15, 1918	0.05
Engels	Copper	1,791,926	1 00		565,273	Oct. 1, 1918	0.01½
First National Copper Company	Copper	600,000	5 00		660,000	Feb. 25, 1919	0.15
New Idria	Quicksilver	100,000	5 00		2,705,000	Jan. 1, 1919	0.25
North Star	Gold	250,000	10 00		5,537,040	June 28, 1919	0.40
Yukon Gold, also Yukon Gold, (also Alaska and Nevada)	Gold	3,500,000	5 00		9,858,110	June —, 1918	0.02½

*Mining and Scientific Press, Vol. 120, p. 731, May 15, 1920.

CHAPTER TWO.

FUELS.

Among the most important mineral products of California are its fuels. This subdivision includes coal, natural gas and petroleum, the combined values of which make up over 50% of the state's entire mineral output.

There are deposits of peat known in several localities in California, small amounts of which are used as a fertilizer; but none has as yet been utilized for fuel.

Comparison of values during 1918 and 1919 is shown in the following table:

	1918		1919		Increase+ Decrease— Value
	Amount	Value	Amount	Value	
Coal	6,343 tons	$16,149	2,983 tons	$8,203	$7,946—
Natural gas	46,373,052 M. cu. ft.	3,289,524	52,173,503 M. cu. ft.	4,041,217	751,693+
Petroleum	99,731,177 barrels	127,459,221	101,182,962 barrels	142,610,563	15,151,342+
Total value		$130,764,894		$146,659,983	
Net increase					$15,895,089+

COAL.

Bibliography: State Mineralogist Reports VII, XII, XIII, XIV, XV. U. S. G. S., Bulletins 285, 316, 431, 471, 581; An. Rep. 22, Pt. III.

Coal has been produced in California since as early as 1860, and until the development of crude oil was an important factor in the mineral industry of the state. As most of it is lignite, the quality is generally poor as compared with other coals on the Pacific Coast markets. However, in competition with fuel oil, coal of all grades has had to take second place. Within recent months, however, owing to the high prices of petroleum products, there have been some inquiries for coal deposits in California. Besides the counties noted below as showing a commercial production, workable bodies of coal are also known in several others, including Alameda, Contra Costa, Mendocino, Shasta, and Siskiyou. Some coal has also been produced, in the past, in Fresno and Orange counties.

During 1919 production was reported from Amador, Monterey and Riverside counties totaling 2983 tons, worth $8,203. That from the Ione mine in Amador County was utilized for steaming and domestic

purposes, mainly locally. That produced at the Stone Cañon property, Monterey County, was consumed at the mine in keeping the mine open and the pumps operating, none being shipped out during 1919.

Tests have been made by the U. S. Geological Survey[1] on some of the Ione lignite (because of its resemblance to some oil shales), to determine if it will yield oil on destructive distillation. Up to 62 gallons of oil per ton was obtained and also 18 pounds of ammonium sulphate as a by-product. The latter is valuable as a fertilizer. Analyses showed: 16% fixed carbon, 31% volatile matter, 46% moisture, 7% ash; and the heating value is 6,060 British thermal units.

The very considerable output of coal in the years previous to 1883 was almost entirely from the Mount Diablo district, Contra Costa County. Later, the Tesla mine in Corral Hollow, Alameda County, was an important producer for a few years. The following tabulation gives the annual tonnages and values, according to available records:

Coal Output and Value by Years.

Year	Tons	Value	Year	Tons	Value
1861	6,620	$38,065	1892	85,178	$209,711
1862	23,400	134,550	1893	72,603	167,555
1863	43,200	248,400	1894	59,887	139,862
1864	50,700	291,525	1895	79,858	193,790
1865	60,530	348,048	1896	70,649	161,335
1866	84,020	483,115	1897	87,449	196,255
1867	124,690	716,968	1898	143,045	337,475
1868	143,676	826,137	1899	160,941	420,109
1869	157,234	904,096	1900	176,956	535,531
1870	141,890	815,868	1901	150,724	401,772
1871	152,493	876,835	1902	88,460	248,622
1872	190,859	1,097,439	1903	93,026	265,383
1873	186,611	1,073,013	1904	79,062	376,494
1874	215,352	1,238,274	1905	46,500	144,500
1875	166,638	958,169	1906	24,850	61,600
1876	128,049	736,282	1907	23,734	55,849
1877	107,789	619,787	1908	18,496	55,503
1878	134,237	771,863	1909	49,389	216,913
1879	147,879	850,304	1910	11,033	23,484
1880	236,950	1,362,463	1911	11,047	18,297
1881	140,000	805,000	1912	14,484	39,092
1882	112,592	647,404	1913	25,198	85,809
1883	76,162	380,810	1914	11,859	28,806
1884	77,485	309,950	1915	10,299	26,662
1885	71,615	286,460	1916	4,037	7,030
1886	100,000	300,000	1917	3,527	7,691
1887	50,000	150,000	1918	6,343	16,149
1888	95,000	380,000	1919	2,983	8,203
1889	121,280	288,232			
1890	110,711	283,019	Totals	5,162,580	$22,876,460
1891	93,301	204,902			

The tonnages in the above table for the years 1861–1886 (incl.) are taken from the U. S. Geological Survey, "Mineral Resources of the U. S., 1910," p. 107. The values assigned for the years previous to 1883 are those given by W. A. Goodyear (Mineral Res., 1882, pp. 93–94), being an average of $5.75 per ton. From 1887 to date the figures are those of the California State Mining Bureau.

[1]U. S. Geol. Surv., Press Bulletin No. 402, March, 1919.

NATURAL GAS.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 3, 16, 19, 69, 73.

Statistics on the production of natural gas in California are in a considerable degree difficult to arrive at, as much of it that is utilized directly at the wells for heating, lighting, and driving gas engines is not measured. Hence, it is necessary to approximate the output of many of the operators in the oil fields.

The figures here given are certainly not over estimated, particularly in the six oil-producing counties. It must be remembered that several of our important oil fields are removed many miles from the site of any other industry, and that the gathering of small amounts of gas and transporting it for any considerable distance may not always be profitable. However, it is undoubtedly a fact that greater saving can frequently be made with profit. Gas traps of various size and design are in use. Some large operators are making commendable efforts to conserve the gas which accompanies oil and is richer than the so-called 'dry gas' occurring in strata which do not produce oil. Wherever feasible, casing-head gas is used in driving gas engines for pumping and drilling, and in firing the boilers of steam-driven plants.

The notable gas development in 1919 in California was the bringing in of two large dry-gas producers by the Standard Oil Company in the Elk Hills in western Kern County. One of these, 'No. 5,' was drilled to a certain stratum on the advice of the State Oil and Gas Supervisor, though the company officials were skeptical. It came in at an estimated flow of 30,000,000 cubic feet per 24 hours.*

Several counties produce gas which is not accompanied by oil, particularly Sacramento and San Joaquin, where it is mixed with manufactured gas for domestic service. The Tulare Lake district in Kings and Tulare counties also does not yield oil.

The value of gas as here shown may be open to some question, but is certainly not too high, as regards the oil counties. There is rather a wide variation in prices quoted for natural gas because such a large proportion is used directly in the field for driving gas engines and firing boilers, and is therefore not measured nor sold. Such companies as have attempted to place a valuation on the gas that was thus used in 1919 gave from 5¢-9¢ per 1000 cubic feet. From the totals shown in the tabulation following herein, the average value for 1919 works out at a fraction under 8¢. Approximately 7000 cubic feet of gas is equal to one barrel of oil in heating value, and is so accounted for by

*Summary of Oil Field Operations, May, 1919, pages 4-8.

many operators. In driving gas engines, about 4000 cu. ft. per 24 hr. are consumed by a 25 h.p. engine, and 63,700 cu. ft. per day for heating a 70 h.p. steam boiler, which figures have been used in compiling this report.

Natural Gas, 1919.

County	M. cubic feet	Value
Fresno	5,191,287	$411,356
Kern	25,363,739	1,618,913
Kings	2,550	1,630
Los Angeles	4,148,476	458,812
Orange	12,039,355	837,439
San Joaquin	200,943	76,200
Santa Barbara	4,084,709	336,092
Tulare	700	295
Ventura	1,038,574	252,240
Butte, Humboldt, Lake, Sacramento and Solano*	103,170	48,240
Totals	52,173,503	$4,041,217

*Combined to conceal output of an individual producer in each.

The annual production of natural gas in California since 1888 is as follows:

Year	Value	Year	Value
1888	$10,000	1905	$102,479
1889	12,680	1906	109,489
1890	33,000	1907	114,759
1891	30,000	1908	474,584
1892	55,000	1909	616,932
1893	68,500	1910	1,676,367
1894	79,072	1911	491,859
1895	112,000	1912	940,076
1896	111,457	1913	1,053,292
1897	62,657	1914	1,049,470
1898	74,424	1915	1,706,480
1899	95,000	1916	2,871,751
1900	34,578	1917	2,964,922
1901	92,034	1918	3,289,524
1902	99,443	1919	4,041,217
1903	74,237		
1904	91,035	Total	$22,638,318

Electricity versus Natural Gas, for Power Purposes.

Electricity is coming into vogue in portions of the San Joaquin Valley oil fields, as a motive power, and as such is showing lower installation, maintenance and operation costs than natural gas equipment. Wherever there are pipe lines available for gas transmission electric power will release the gas for other duties. A recent paper[1] dealing with this subject, is quoted herewith at some length, on account of the valuable data it gives, particularly with reference to comparative costs:

[1]Balzari, R. A., Kommers, O. A., and Boller, F. V., Electricity in the development of oil lands: Journal of Electricity, Vol. 44, pp. 373-377, No. 8, Apr. 15, 1920.

"Comparison of Motive Power.

"In order that we may consider the relative merits of electricity with the other motive powers that have been used in the oil fields, let us compare in percentage cost the relation of the electrical installation to the steam and gas installation and also the relation of the operation and maintenance of an electrically operated plant to that of steam and gas. In making the comparison, we are only considering that portion of the oil well equipment which would be eliminated by the use of electric motors.

"In the steam engine driven plant, which has been the most commonly used, the cost to the oil producer per well installed, averages one and a half times as much as that of an electric plant. This does not take into consideration the cost of water. The cost of water in Central California is a very important item, as at several points water is not available at all and it is necessary to pipe it from some distant point. In such cases the water cost is very high. In other localities they are able to obtain their own well supply. Wells in these districts cost from $3,000 to $10,000 each. The number of oil wells served by the boiler plant does not alter the water well cost. The water obtained is of very poor quality being quite heavy in alkaline salts.

"The gas engine driven installation costs the producer 1.6 times the cost of the electrical installation. This is on the assumption that the producer does not have excessive length of pipe to run to his wells for furnishing the necessary gas to operate the engine.

"The cost of operating a steam driven well varies over a very wide range. We have a minimum reported cost of operation of $2 per day per well. This runs as high on other leases as $10 per day per well. This wide variation is explained by several factors. The variation in water costs, and the fact that the low cost per day occurs where the most economical character of steam installation is made and one boiler plant is supplying a large number of wells. As a usual thing the steam lines are uneconomical, the heat losses during cold weather are great, as these steam lines are not well lagged. The steam engines are noncondensing, and a very low operating effiiciency.

"The labor cost of a steam driven installation is materially higher than for an electrically driven plant. This is caused by the necessity for close attention to the boilers and engines. If for any cause steam pressure drops, the pumper must be available to adjust the engine speed so that the well is pumped at the most efficient speed.

"The gas engine user commonly does not know his costs of operation and maintenance. If you ask him what his fuel costs are, he will tell you that his gas does not cost him anything, therefore, he does not have any fuel charges. It might be possible for him, however, to collect his gas and sell it in the field at a fair return. He does not keep a separate record of his engine maintenance charges, although it is necessary for him to maintain a well equipped machine shop and a corps of high-grade mechanics in order to keep his gas engines operating. We have interviewed a large number of operators of gas engines and have been unable to get a definite statement as to costs from any of the organizations. They have no absolute records, so do not wish to make statements. The field superintendent, however, of one of the larger companies who had in a personal way kept account of gas engine operation, assured me that the cost of operation of their engines was at least $2 per day per well.

"The cost of operating a well by electricity is largely a question of power. The maintenance charges on a motor installation are very low, amounting to only a few dollars per year. We have records showing wells that are pumped and maintained at an average cost of 50 cents per day (individual motor drive). Where the wells are pumped from jack plant the cost runs as low as 12 cents per day. The Coalinga Mohawk Oil Company at Coalinga, whose wells range from 4000 to 4800 feet in depth, pump for an average of $1.80 per day. These give pumping costs over the wide range of wells, that is from the shallow well at 50 cents per day to the deep well at $1.80 per day. We have prepared a fair exhibit which gives in tabulated form cost data on the electrically operated well that we feel can be taken as an average for the entire oil fields.

"There is one point that I wish to call to your attention, however, and that is the maintenance charges against the electric motor. The largest percentage of maintenance charges on these reports, is repairing of counter shafts which are not made by the manufacturers of electrical equipment, but which, due to the fact that they are necessary in a motor driven installation have been charged against the motor maintenance cost. There is being designed at the present time a counter shaft to eliminate all the troubles that have been experienced in the past and which will remove practically entirely the charges now assessed against the electrical installation.

"Oil Production.

"Oil producing companies that were formerly operating on a steam drive and are now operating by electric drive claim a greater production by electric than by steam drive. This is evident when you consider the two methods of operating the well. In the steam driven unit the steam pressure at the well will vary according to the temperature of the atmosphere inasmuch as the steam lines from the boiler to the wells are never sufficiently lagged to insure uniform temperature of the line. In addition to this the accumulation of water in the steam line causes at times a drop in pressure and in each case a drop in pressure means a slowing down of the engine which in itself causes a reduction in production. The attendant when he makes his periodical rounds adjusts the speed of the equipment, but in the meantime the well has lost in production due to the lower speed at which it was operated.

"This is not the case, however, with an electrically driven pump, inasmuch as the motor always operates at the predetermined speed until changed by an attendant. This insures a uniform production.

"The gas engine, due to engine troubles, has not the reliability of the motor. One operator who has replaced his gas engine by motors, claims that his production increased at least 20 per cent due to the uniformity of drive.

"The oil companies utilizing electric motors say that they would under no consideration return to the older methods of drive. They prefer the motor for its reliability in service and the ease with which it can be handled.

"Drilling by Electricity.

"For many years the oil well drillers would not try the motor for drilling purposes. This, as was the case in pumping, was due to their inherent desire to follow custom. Finally, however, a well was successfully drilled by standard tools with an electric motor and now there are over twenty drilling rigs running by the use of electricity.

"The electrical installation for drilling can be put in at less than one-half of the cost for a steam installation, not taking into consideration the additional cost of water. The average cost of power for five electrically operated drilling outfits in the Midway fields over a period of one year is $90 per month per equipment. A steam installation could not be operated in the same field as the electrics are working for a cost less than $300 per month. Just as good drilling time is made with the motor as with steam. The drillers after once becoming accustomed to the motor drive would not go back to the use of steam power.

"COST OF ELECTRIC POWER.

Southern Pacific—Coalinga Field. June to November, 1919, Inclusive.

Wells 7, 11, 12, 14, 16, 18, 20, 55, 57, 112, 114, 119, 120, 121, Section 19-C. Wells 2, 3, 7, 8, Section 31-A. Wells 38, 40, 339, Section 33-A. Wells 48, 49, 50, Section 11-A.

Nos. 57, 112, 114, 119, 120, 121—wells on only part of above period.

Month	June	July	August	Sept.	Oct.	Nov.
Total production, bbl.	11,233	8,744	13,298	12,996	20,443	17,999
Total number wells	17	17	20	20	24	23
Number wells individual drive	13	13	16	16	17	17
Number wells on jack	4	4	4	4	7	6
Total k.w. hours used	34,945	34,434	47,653	46,201	51,081	67,797
Total cost of power	$379 53	$375 10	$505 66	$504 88	$544 43	$730 52
Total cost of labor (inspection, repairs, etc.)			144 10	68 78	239 79	130 84
Total cost of repair parts (motors and counter shafts)			78 10	58 90	75 32	14 38
Average cost per k.w. hour	.01084	.01089	.01061	.01092	.01065	.01077
Average k.w. hours used per bbl.	3.11	3.93	3.58	3.555	2.498	3.7689
Average hrs. pumped per well per day	20.25	20	19	20.4	19.8	17
Average cost per bbl. for power	.0337	.0427	.03802	.03885	.02663	.04057
Average cost per well per day for—						
Power	.7423	.7521	.8155	.8145	.8249	1.025
Labor			.240	.114	.322	.18
Repair parts			.126	.0981	.101	.022
Power and labor			1.115	1.02	1.30	1.23
Average cost per bbl. for labor, repairs and power			.0547	.0485	.04204	.0486
Average gravity of oil	16.8	16.8	15.8	15.8	15.8	15.8
Average depth; exclusive of the 4 wells on a jack plant from which oil is pumped (feet)	2,200	2,200	2,200	2,200	2,200	2,200
Line pressure average (pounds)	200	200	200	200	200	200

Total power used, includes power consumed in pumping, pulling rods and tubing, and bailing.

Labor includes regular inspection, oiling and repairing, motor counter shaft and belt from motor to counter shaft. Does not include labor of pumpers and pulling gang.

Repairs includes motor, counter shaft and belt repairs.

"COST OF ELECTRIC POWER.

Jack Plant.

These wells are included in preceding table. Wells 2, 3, 7, 8, Section 31-A.

Month	June	July	August	Sept.	Oct.	Nov.
Total k.w. hours	1,385	1,306	1,372	1,417	1,393	1,725
Total power cost	$19 29	$18 31	$19 13	$19 69	$19 39	$23 55
Average cost per k.w. hour	.01392	.01401	.01394	.01389	.01392	.01365
Average k.w. hours per well per hour	.48	.45	.46	.476	.483	.58
Average k.w. hours per well per 24 hrs.	11.52	10.88	11.06	11.42	11.6	13.911
Average daily production per well, bbl.	11.4	9.89	7.3	13.46	12.74	11.61
Total production per month, bbl.	1,370	1,187	906	1,669	1,529	1,440
Average gravity of oil	16.8	16.8	16.8	16.8	16.8	16.8
Average hours per well per day	23.78	24	20.3	23.4	24	23.6
Average k.w. hours per bbl. of oil	1.009	1.1	1.51	.843	.911	1.198
Average cost for power per well per day	.16075	.1525	.154	.1588	.1618	.19
Average cost for power per bbl. of oil	.01408	.0154	.021	.0118	.01268	.01635

Average depth oil is pumped, 950 feet.
Tail pump on each well, line pressure average 200 pounds.

"Another interesting record was recently made in the Santa Maria fields, when a well was put down 2700 feet with an electrically operated rotary drilling rig in forty-eight days. The power cost on this rig was $8.45 per day. Due to the location of the well, steam could not have been used at a cost anywhere near that of electricity.

* * * * * * *

"The average installation of motors is 10 hp. for pumping and 30 hp. for pulling the well. These are not separate motors, but one motor connected for 10 hp. continuous duty as a pumping motor, or 30 hp. intermittent duty as a pulling motor. The size of motor being used with standard tools in drilling, is at present 75 hp. On a rotary installation, the company working in the Santa Maria fields used a 75-hp. variable speed motor operating the rotary, and a 40-hp. constant speed motor for operating the circulating pump.

* * * * * * *

"Present Development.

"The Oil Bureau of the State of California gives some interesting figures as to the present development of the oil industry in this state. There are at the present time 91,792 acres of proven land in the State of California. There are 9127 producing wells. There is approximately 100,000 acres of land which is considered oil land, but which has not been proven to date. The Bureau considers that to properly develop oil land there should be at least one well on every eight acres of ground, which would mean that if the unproven territory proves up we should have in this state about 24,000 producing wells. At present the central stations tell us that we now have 2110 wells operating by electricity, which leaves 7017 wells which should be operating by electricity, or which can be operated by this method as soon as power is available. There are also 12,500 wells which we hope to develop during the next ten years. This shows a wonderful load which is ready to be taken as soon as there is a sufficient supply of electrical energy."

The following data relative to the extent that electric power is now being applied in the oil fields, has been furnished us, by the San Joaquin Light and Power Corporation, through the courtesy of Mr. I. W. Alexander,[1] Manager of Stock Sales Department; and "is complete in so far as it pertains to the oilfields to which we supply electric current:"

[1]Correspondence.

"San Joaquin Light and Power Corporation Oilfields Operations July 1, 1920.

	Kern River	West side Kern County	Coalinga	Santa Maria	Total
Number of wells pumped by electric jacks	1,070	100	132	21	1,323
Number of individual motor pumped wells	269	497	260	87	1,113
Number of individual motor drilling wells	0	5	2	3	10
Total number wells operated by electricity	1,339	602	394	111	2,446
Number of companies using motor (pump and jack)	20	50	42	8	120
Number of companies using electric dehydrators	1	20	6	5	32
Number of electric dehydrators	1	30	8	7	46

Gasoline from Natural Gas.

As above indicated, more or less gas usually accompanies the petroleum in the oil fields. Approximately 50 plants are in operation manufacturing gasoline by compression or absorption from this 'casing-head gas.' After the gasoline is extracted, the remaining 'dry gas' is taken into the pipe lines, by which it is distributed to consumers, both domestic and commercial.

In the Midway field, some of the casing-head gasoline is obtained as an incidental product to the compressing of the natural gas preliminary to transmission through the gas pipe lines. Some concerns market casing-head gasoline separately, while others turn it into the oil pipe lines, thus mixing this high-gravity gasoline with the crude oil for transportation to the refinery, where it is later regained. A total of 38,034,256 gallons of casing-head gasoline from all fields was reported by 29 companies, as made during 1919 and utilized directly as such. It was distributed by counties, as follows:

County	Gallons gasoline
Fresno	427,095
Kern	19,062,781
Los Angeles	1,443,769
Orange	7,784,830
Santa Barbara	8,112,931
Ventura	1,202,850
Total	38,034,256

The largest natural gas field of commercial importance thus far developed in California is in the Midway district, followed by Orange, Santa Barbara, Fresno, and Los Angeles counties. The Southern California Gas Company operates a 12-inch pipe line from the Midway field, a distance of 107 miles, to Los Angeles, where it supplies gas to local distributing companies. The Valley Natural Gas Company supplies gas to consumers in the Midway field and to local distributing companies at Fellows, Taft, Maricopa, Bakersfield, and the Kern River fields. The Santa Maria Gas and Power Company distributes gas around Santa Maria, from wells in the neighboring oil fields.

PETROLEUM.

Bibliography: State Mineralogist Reports IV, VII, X, XII, XIII. Bulletins 3, 11, 16, 19, 31, 32, 63, 69, 73, 82, 84.

Chief of the fuels of California is petroleum. A complete description of the industry is to be found in Bulletin 69, issued in 1915 by the State Mining Bureau; supplemented by Bulletins 73, 82 and 84, annual reports of the Oil and Gas Supervisor, 1915–1918, and by the 'Summary of Operations,' issued monthly since April, 1919. The state law providing for the regulation of drilling and maintenance of oil and gas wells by the State Mining Bureau has been in effect since 1915. The chief aim is to protect the oil deposits from damage by water, and to aid producers in their work. A staff of technically trained men maintain offices in the various fields.

The oil production for California for 1919, as shown by the sworn statements made to the State Mineralogist for the Department of Petroleum and Gas, by the producers from 8932 wells (except part of the Los Angeles City field) amounted to 101,073,517 barrels net. 'Net' means that a deduction of approximately 2% has been made for water. The oil consumed for fuel at the wells is also included. This shows an increase of 1,614,340 barrels from the similar net figures of 1918.

To the above amount, we have here added 109,445 barrels, being the output of various small operators in the Los Angeles City field, not included in the reports to the Oil and Gas Supervisor, making a total for the year 1919 of 101,182,962 barrels, valued at $142,610,563. Compared with 1918, this is an increase of 1,451,785 barrels in quantity, and of $15,151,342 in value. This great advance in value is due to the continued increase in the average price per barrel for all fields and grades which began in 1916, as will be seen in Table B, *post*. The total or average figures on price per barrel at the well are difficult to obtain, as it must be remembered that a large portion of the crude oil does not enter the open market, but is consumed or refined directly by the producers. The prices given are for oil which is actually sold, and are known to be accurate.

Features of 1919.

The outstanding feature of California oil production is its fairly constant rate for several years past. Such a condition may be expected to continue for several years and any shortage of oil or its products will be due to an increased consumption. Los Angeles and Ventura were the only counties showing marked increase in production. Los Angeles County increased approximately 5,000,000 bbl., or 50%, while Ventura gained 26%, or 345,731 bbl. The increase in Los Angeles

County was largely due to the Montebello field. Fresno County practically maintained its standing with a production of 16,091,037 bbl., all from the Coalinga field. The greatest decline was in Orange County, which amounted to 1,368,669 bbl., or nearly 9%. Kern County decreased 1,315,882 bbl., or nearly 3%. Santa Barbara County lost 1,245,022 bbl., or 17% of its previous yield.

There is a natural decrease in production from all oil wells as time passes after their completion. The average daily production from California wells decreases about two barrels each year. In order to maintain a given total output, new wells must be continually drilled. The area of proved oil land increased about 3% with a total of 91,792 acres. All the important oil producing counties added to the increase.

The use of electricity as a motive power is increasing in the oil fields, superseding both casing-head gas and crude-oil fuel. It is proving economical in cost, not only of operation, but also of installation and maintenance; and permits of increased oil production from the wells, owing to steadier and more continuous operation. A recent authoritative magazine article on this subject is quoted elsewhere herein,* under Natural Gas.

The Gasoline Shortage.

A recent press bulletin[1] of the Oil Department of the State Mining Bureau deals with the production of crude petroleum as related to the now acute situation as regards the adequacy of the supply of motor gasoline:

"The recent shortage of gasoline in California has caused numerous letters to be directed to the State Oil and Gas Supervisor inquiring whether or not owners of producing oil wells have capped them in such a manner as to retard production and cause a shortage in oil and its various products.

"The State Supervisor has jurisdiction only over the methods of drilling wells in order to protect the natural deposits. However, the work of supervision requires that monthly production reports of each and every well shall be filed with the Deputy Supervisor located in the various fields. Through the local offices of the department, the Supervisor is, therefore, regularly advised as to condition of the oil industry throughout the state.

"One of the outstanding features of oil production in California is that for *a period of about four years, the production has been maintained at a fairly constant figure.*[2] Such a condition does not prevail in many other states. Ordinarily, the production of a state rises to a maximum and steadily declines therefrom.

"On the last day of December, 1919, sworn statements filed by all the oil producers in the state show that there were 8928 wells in operation as against 8188 wells in operation at the end of the year 1918. The state law requires that notices of intention to drill new wells shall be filed with the State Oil and Gas Supervisor prior to commencement of work. Up to June 19, this year, 425 such notices have been received as compared with only 291 at the same date in the preceding year.

"The Supervisor recently made a direct inquiry into this matter through his various field deputies. The conclusion arrived at from the foregoing facts is that *in all fields there is evidence of effort to obtain a maximum production.*"[2]

During the year 1919, a total of 20,341,828 gallons of gasoline valued at $5,882,502 was exported from California through the port of San Francisco, and 114,158 gallons, valued at $41,051 from the Los Angeles district. The bulk of that exported went to New Zealand, Australia,

*See page 19, *ante*.

[1]Weekly Press Bulletin No. 244, June 26, 1920.
[2]The italics are ours.—W. W. B.

Philippine Islands, and Canada with smaller amounts to Mexico, Central and South America. The following figures of the exports from San Francisco for the first five months of 1920 are reproduced from the records of the U. S. Bureau of Foreign and Domestic Commerce:

Month	Gallons	Value
January	2,680,396	$909,378
February	1,413,080	445,140
March	836,381	245,416
April	967,628	273,412
May	4,389,970	1,373,536
Totals	10,287,455	$3,246,882

Of this total, New Zealand received 4,287,310 gallons and Australia, 1,784,922, with large shipments also going to Canada, Central and South America. During the first four months of 1920, a total of 68,244 gallons was exported through the Los Angeles customs district, to Mexico and Japan.

Production Figures.

The following table gives the production by counties for 1919, compared with the 1918 figures:

TABLE A.

Production and Value of Oil by Counties.

County	1918		1919	
	Barrels	Value	Barrels	Value
Fresno	16,068,919	$19,138,083	16,091,037	$20,805,711
Kern	49,049,917	61,410,496	47,734,035	64,440,947
Los Angeles	10,125,190	13,567,755	15,076,633	20,805,754
Orange	15,730,462	22,211,412	14,458,722	26,893,223
San Luis Obispo	62,744	56,783	31,656	32,922
Santa Barbara	7,334,104	9,057,618	6,089,082	6,850,217
Santa Clara	20,499	34,848	16,724	26,695
Ventura	1,339,342	1,982,226	1,685,073	2,755,094
Totals	99,731,177	$127,459,221	*101,182,962	$142,610,563

*See page 23, *ante*.

TABLE B.

Average Price of Oil, by Counties, in Cents per Barrel.

County	1914	1915	1916	1917	1918	1919
Fresno	$0.452	$0.545	$0.516	$0.825	$1.191	$1.293
Kern	.409	.423	.641	.893	1.252	1.350
Los Angeles	.550	.629	.651	1.176	1.340	1.380
Orange	.675	.512	.663	1.003	1.412	1.860
San Luis Obispo	-------	-------	.450	.926	.905	1.040
Santa Barbara	.460	.611	.794	.808	1.235	1.125
Santa Clara	.530	.666	.666	1.387	1.700	1.600
Ventura	1.050	.855	1.045	1.318	1.480	1.635
State average	$0.461	$0.479	$0.636	$0.908	$1.278	$1.409

The low price in Santa Barbara County for 1919 is due to a large production of 8° to 10° gravity oil from the Casmalia field, which brought only about 50¢ per barrel.

TABLE C.

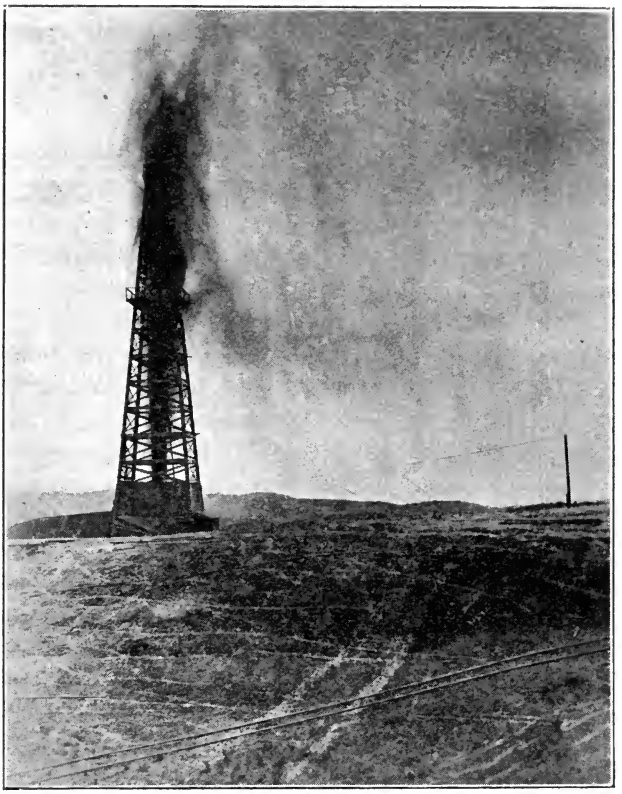
The annual production since discovery in 1875 is as follows:

Year	Barrels	Year	Barrels
1875	175,000	1899	2,677,875
1876	12,000	1900	4,319,950
1877	13,000	1901	7,710,315
1878	15,227	1902	14,356,910
1879	19,858	1903	24,340,839
1880	40,552	1904	29,736,003
1881	99,862	1905	34,275,701
1882	128,636	1906	32,624,000
1883	142,857	1907	40,311,171
1884	262,000	1908	48,306,910
1885	325,000	1909	58,191,723
1886	377,145	1910	77,697,568
1887	678,572	1911	84,648,157
1888	690,333	1912	89,689,250
1889	303,220	1913	98,494,532
1890	307,360	1914	102,881,907
1891	323,600	1915	91,146,620
1892	385,049	1916	90,262,557
1893	470,179	1917	95,396,309
1894	783,078	1918	99,731,177
1895	1,245,339	1919	101,182,962
1896	1,257,780		
1897	1,911,569	Total	1,240,198,740
1898	2,249,088		

TABLE D.

The total value since 1887 is as follows:

Year	Value
1887-1909	$136,693,228
1910	37,689,542
1911	40,552,088
1912	41,868,344
1913	48,578,014
1914	47,487,109
1915	43,503,837
1916	57,421,334
1917	86,976,209
1918	127,459,221
1919	142,610,563
Total	$810,839,592



Well flowing over 10,000 barrels of oil per day. Elk Hills, Kern County, California.

The following table shows the distribution by fields of the 1919 output, compared with 1918, as given by the Standard Oil Company:

TABLE E.
Production by Fields.*
(In barrels of 42 gallons.)

Field	1918	1919
Kern River	7,921,515	7,563,025
McKittrick	3,050,627	2,810,848
Midway-Sunset	34,048,933	32,003,952
Lost Hills-Belridge	5,420,079	4,554,821
Coalinga	16,283,066	16,385,610
Lompoc and Santa Maria	7,143,750	6,030,910
Ventura County and Newhall	1,386,518	1,792,465
Los Angeles and Salt Lake	1,397,781	1,341,415
Whittier-Fullerton	24,903,613	28,657,683
Summerland	54,613	53,680
Watsonville	27,375	27,375
Totals	101,637,870	101,221,784
Net decrease		461,086

*Standard Oil Bulletin, January, 1920.

The following table is compiled from the monthly statements contained in the Standard Oil Bulletin:

TABLE F.

Well Operations, by Fields, 1919.

Field	Producing Dec., 1918	Producing Dec., 1919	Completed during year	Abandoned during year
Kern River	1,996	2,067	77	1
McKittrick	333	341	8	4
Midway-Sunset	2,208	2,348	166	26
Lost Hills-Belridge	535	561	33	5
Coalinga	1,140	1,229	98	28
Lompoc and Santa Maria	343	378	35	4
Ventura and Newhall	456	504	36	5
Los Angeles and Salt Lake	664	665	1	
Whittier-Fullerton	784	887	105	5
Summerland	142	142		
Watsonville	5	5		
Totals	8,606	9,127	559	78

The proportion of heavy and light oil produced in the various fields is shown by the following figures, for which we are indebted to the Standard Oil Company. Oil below 18° Baumé may be considered as largely unrefinable, or fuel oil; while the lighter oils yield varying amounts of refined products and a very large proportion of residuum and fuel oil. A few years ago, the total amount of heavy oil was in excess of the light oil.

TABLE G.

Production of Light and Heavy Oil, by Fields, 1919.

Field	Under 18° (barrels)	18° and over (barrels)	Total (barrels)
Kern River	5,563,025		7,563,025
McKittrick	2,810,848		2,810,848
Midway-Sunset	9,937,698	22,066,254	32,003,952
Lost Hills-Belridge	1,456,594	3,098,227	4,554,821
Coalinga	5,604,646	10,780,964	16,385,610
Santa Maria-Lompoc	3,151,785	2,879,125	6,030,910
Ventura County and Newhall	101,788	1,690,677	1,792,465
Los Angeles and Salt Lake	1,178,383	163,032	1,341,415
Whittier-Fullerton	988,555	27,669,128	28,657,683
Summerland	53,680		53,680
Watsonville		27,375	27,375
Totals	32,847,002	68,374,782	101,221,784

In addition to consuming the current production of crude oil, the storage was drawn upon at an average rate of 130,217 barrels per month during 1919. According to the Standard Oil Company* the

*Standard Oil Bulletin, January, 1920.

stocks on hand December 31, 1919, amounting to 30,480,323 barrels, a decrease of 1,562,600 barrels from the 32,042,323 barrels on hand December 31, 1918.

Financial and Operating Condition of California Oil Fields, 1919.

Financial results of the oil business during 1919, are shown by the following tables. The outstanding features are: (1) the continued substantial increase of prices for all grades over the 1918 figures; (2) a decrease in most of the fields in the number of barrels per well per day yield; (3) an increase in operating costs per barrel, resulting in raising the cost per well per day.

Increases were registered in the number of barrels-per-well-per-day yield in Los Angeles-Orange and Ventura counties, the former on account of developments in the Montebello field, and the latter from scattered new production in several small fields. Another interesting feature is that the Kern River field, as in 1918, again shows a fractional increase in the yield per-well-per-day, which means that that field is more than holding its own. This is due in large part to the corrective measures being taken in the systematic repairing of oil wells against water encroachment. Portions of this field have been among the worst water-flooded in the state. Systematic repair work was begun there in 1918, under the supervision of the Department of Petroleum and Gas of the State Mining Bureau. Results following such repairs indicate that the production of oil can be nearly or quite doubled, if proper steps are taken to stop the flow of water; but this work can properly be pursued only after thorough engineering investigation of the underground conditions, covering not only the particular property involved but all neighboring properties.

Operating cost per well is not always lower for the dividend companies than others. Profitable operations seem to depend generally upon large wells, high-grade oil, and proximity to market. There is nothing to indicate that unnatural causes or manipulation have affected the profits of one producer against another. It may be noted that both price and profits have usually been greater in the Los Angeles-Orange-Ventura fields than in others, doubtless largely due to the proximity to market and higher grades of oil. Crude oil testing as high as 56° Baumé is being obtained from some of the Ventura County wells.

TABLE H.

Capitalization.

Field	Number of companies considered*	Per cent of total product of field	Capital	
			Cash	Property
Coalinga	41	26	$2,432,254	$8,248,487
Kern River	46	36	5,999,478	7,273,207
Midway	64	35	9,311,609	30,424,310
Sunset	24		2,719,880	5,805,059
McKittrick, Lost Hills, Belridge	17	28	1,137,508	9,787,764
Santa Barbara County	13	23	1,037,295	4,998,986
Ventura County	17	65	722,873	7,296,583
Los Angeles and Orange Counties	30	16	5,574,869	6,233,075
Subtotals	252		$28,935,766	$80,067,471
Miscellaneous and marketing companies	33	54	111,663,309	99,363,765
Totals	285		$140,599,075	$179,431,236

*See also Table J, following.

TABLE I.

Dividends Paid by Oil Companies, 1914-1919.

Field	1914		1915		1916		1917		1918		1919	
	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value
Coalinga	15	$1,048,840	13	$283,660	12	$217,949	20	$712,331	23	$1,055,600	24	$1,352,969
Kern River	20	205,258	20	187,962	23	405,556	22	306,508	31	609,293	27	1,235,877
Midway	25	917,981	23	853,376	29	1,207,974	34	1,938,769	42	3,015,862	32	8,360,447
Sunset and Maricopa	5	166,152	7	149,932	5	241,200	14	682,644	15	638,926	15	595,535
McKittrick, Belridge and Lost Hills	8	493,339	7	397,827	7	434,154	14	837,129	12	708,984	9	548,224
Santa Barbara County	6	480,534	6	317,727	7	293,025	6	923,228	5	286,768	5	355,490
Ventura County	4	125,832	2	120,143	5	126,812	3	71,637	2	4,400	4	120,584
Los Angeles and Orange counties	13	2,453,981	14	863,677	12	1,222,598	16	3,079,447	14	1,201,021	17	2,373,403
Subtotals	96	$5,891,917	92	$3,174,304	100	$4,149,298	129	$8,551,693	144	$7,520,854	133	$14,942,529
Miscellaneous and marketing companies	9	9,384,308	13	9,926,044	13	*38,383,270	12	#40,981,214	11	19,984,138	26	20,476,322
Totals	105	$15,276,225	105	$13,100,348	113	$42,532,568	141	$49,532,907	155	$27,504,992	159	$35,418,851

*Includes a 50 per cent stock dividend of the Standard Oil Company. #Includes a 33⅓ per cent stock dividend of the Standard Oil Company.

TABLE J.

Prices of Light and Heavy Oils, and Operating Data, 1919.

Field	Price				Operating data					
					All companies considered*			Dividend companies‡		
	Under 18° Baume	18° and over	Average price	Price to dividend companies	Barrels per well per day yield	Operating cost per well day	Operating cost per barrel	Barrels per well per day yield	Operating cost per well day	Operating cost per barrel
Coalinga	$1.286	$1.350	$1.293	$1.290	23.5	$10.29	$0.438	26.3	$11.31	$0.430
Kern River	1.170		1.170	1.163	10.3	3.63	0.353	9.8	2.78	0.284
Midway	1.280	1.555	1.440	1.460	30.9	11.21	0.364	33.9	11.80	0.348
Sunset and Maricopa	1.191	1.350	1.230	1.271	**20.5**	**9.33**	**0.455**	**22.1**	**10.44**	**0.473**
McKittrick, Lost Hills and Belridge	1.165	1.230	1.191	1.142	22.0	7.28	0.331	20.7	5.96	0.288
Los Angeles and Orange counties	1.230	1.732	1.719	1.825	**28.1**	**21.61**	**0.769**	**27.9**	**24.55**	**0.880**
Santa Barbara County	[1]0.617	1.542	1.125	1.565	37.4	19.97	0.534	32.0	18.76	0.587
Ventura County	**1.038**	**1.653**	**1.635**	**1.893**	**21.3**	**9.03**	**0.424**	**12.3**	**4.72**	**0.384**

*See Table H, preceding. ‡See Table I, preceding.

It should be noted that in the case of a county like Ventura with only a few producers, the averages are not so significant as in other fields with a large number of operators. The figures of a single large operator in such a case can materially affect the general average if they should be much above or below the average of the others.

[1]This low price was due to a large production of 8°-10° gravity oil from the Casmalia field, which brought an average of only 50 cents per barrel.

Proved Oil Land.

The area of proved oil land increased about 3% during 1919, to a total of 91,792 acres, with all of the important oil producing counties contributing to the increase. Estimates of the total amount of oil which can be recovered from the land are little better than pure guesses but it does seem most probable that the average acre will ultimately yield much less than fifty thousand barrels.

The figures in detail are as follows:

TABLE K.

County	Land (acres)	Wells (No.)
Fresno	13,924	1,274
Kern	58,371	5,324
Los Angeles	2,931	*833
Orange	3,879	542
San Luis Obispo	772	17
Santa Barbara	9,663	448
Santa Clara	80	9
Ventura	2,172	481
Totals	91,792	8,928

*Not including a portion of the Los Angeles City field, which portion contains approximately 200 wells.

CHAPTER THREE.

METALS.

The total value of metals produced in California during 1919 was $25,120,779. The chief of these is, and always has been, gold, followed in order in 1919 by copper, quicksilver, silver, manganese, lead, tungsten, zinc, platinum, and iron. Deposits of ores of nickel and vanadium have also been found in the state, although there has as yet been no commercial output of them. There was no production of antimony, cadmium, nor molybdenum. The above total value is a net decrease of $12,565,293 from the 1918 total of $37,686,072. This was due to the marked drop in all of the metals, except gold and platinum, which showed small proportional increases. The greatest loss was made by copper, of $7,683,637; followed by tungsten, $2,612,906; and quicksilver, $1,226,091.

California leads all states in the Union in her gold production, and the precious metal is widely distributed throughout the state. Twenty-nine of the fifty-eight counties reported an output in 1919 from either mines or dredges.

Copper, which is second in importance among the metals of the state, occurs in the following general districts: the Shasta County belt, which is by far the most important; the Coast Range deposits, extending more or less continuously from Del Norte in the north to San Luis Obispo County in the south; the Sierra Nevada foothill belt, starting in Plumas and running in a general southerly and southeasterly direction through the Mother Lode counties and ending in Kern; the eastern belt in Mono and Inyo counties; and the southern belt, in San Bernardino, Riverside, and San Diego counties.

Silver is not generally found alone in the state, but is associated to a greater or less extent with gold, copper, lead, and zinc.

Quicksilver has for many years been one of the state's staple products and California supplies approximately 75% of the nation's output of this metal.

Tungsten is found in but few other localities of importance in the United States.

Large deposits of iron ore have long been known in several sections of the state, but for various economic reasons this branch of the mineral industry thus far has made only slight progress here.

A comparison of the 1919 metal output with that of 1918 is afforded by the following table:

Metal	1918		1919		Decrease— Increase+ Value
	Amount	Value	Amount	Value	
Cadmium	*	*			* —
Copper	47,793,046 lbs.	$11,805,883	22,162,605 lbs.	$4,122,246	$7,683,637—
Gold		16,529,162		17,335,100	805,938+
Iron ore	3,108 tons	15,947	2,300 tons	13,796	2,151—
Lead	13,464,869 lbs.	956,006	4,139,562 lbs.	219,397	736,609—
Manganese ore	26,075 tons	979,235	11,569 tons	451,422	527,813—
Molybdenum	*	*			* —
Platinum	571 oz.	42,788	418 oz.	60,611	17,823+
Quicksilver	22,621 flasks	2,579,472	15,200 flasks	1,353,381	1,226,091—
Silver		1,427,861		1,244,464	183,397—
Tungsten concentrates	1,982 tons	2,832,222	214 tons	219,316	2,612,906—
Zinc	5,565,561 lbs.	506,466	1,384,192 lbs.	101,046	405,420—
Cadmium and molybdenum*		11,030			11,030—
Totals		$37,686,072		$25,120,779	
Net decrease					$12,565,293—

*Combined to conceal output of a single operator in each.

ALUMINUM.

Bibliography: Bulletins 38, 67.

No workable deposits of bauxite have been discovered in the state, although from time to time small quantities of the impure material have been the foundation of extravagant reports regarding such discoveries.

ANTIMONY.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38.

Antimony is known to exist in a number of places in California, having been reported from Kern, Inyo, Nevada, Riverside, San Benito, and Santa Clara counties. The Kern County deposits, some of which carry the native metal, are possibly the best known, and efforts were made to work some of them before California was a part of the United States. The commonest occurrence is in the form of the sulphide, stibnite. No continuous production, however, has been maintained, the output for 1915 to 1917 inclusive, being the first reported since 1901. There was none produced in 1919.

From the low point of 5.44¢ to 7.11¢ per pound, according to brand, in July, 1914, the price of antimony rose gradually, though not steadily, to 44¢ by the middle of January, 1916. American antimony, for the first time in many years, appeared on the market in competition with the Chinese and Japanese product. From $1 to $2.25 per unit was paid for ore, and at first a minimum of 50% accepted; but, later, some

lower grade ore was smelted. The price remained at 44¢ (San Francisco quotations) until the middle of April, 1916, then declined quite rapidly to 10¢ in August. It varied around 10¢ to 14¢ during most of 1917 and 1918. With the price below 12¢ per pound for the metal, few if any of the California mines can operate profitably.

The production of antimony by years since 1887 has been as follows:

Year	Tons	Value	Year	Tons	Value
1887	75	$15,500	1900	70	$5,700
1888	100	20,000	1901	50	8,350
1893	50	2,250	1915	510	35,666
1894	150	6,000	1916	1,015	64,793
1895	33	1,485	1917	158	18,786
1896	17	2,320	1918		
1897	20	3,500	1919		
1898	40	1,200			
1899	75	13,500	Totals	2,363	$199,050

BISMUTH.

Bibliography: Bulletins 38, 67. Am. Jour. Sci. 1903, Vol. 16.

Several bismuth minerals have been found in California, notably native bismuth and bismite (the ochre) in the tourmaline gem district in San Diego and Riverside counties near Pala. Other occurrences of bismuth minerals, including the sulphide, bismuthinite, have been noted in Inyo, Fresno, Nevada, Tuolumne, and Mono counties, but only in small quantities. The only commercial production recorded was 20 tons valued at $2,400, in 1904, and credited to Riverside County.

In 1917, a few pounds of bismuthinite (Bi_2S_3) with associated bismutite ($Bi_2CO_5.H_2O$), was taken out at the United Tungsten Copper mine, in the Morongo district, San Bernardino County. It is associated with scheelite in a contact deposit between limestone and granite.

Recovery of bismuth from blister copper in the electrolytic refinery has been noted,[1] ranging as high as 27.3 pounds of metallic bismuth per 100 tons of blister copper from the Iron Mountain, Shasta County, ores.

The uses of bismuth are somewhat restricted, being employed principally in the preparation of medicinal salts, and in low melting-point or cliché alloys. These alloys are utilized in automatic fire sprinkler systems, in electrical fuses, and in solders.

CADMIUM.

In 1917 and in 1918, several thousand pounds of cadmium metal, in sticks, was recovered by the electrolytic zinc plant of the Mammoth Copper Company in Shasta County. The 1917 output was the first

[1]Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217-218.

commercial production of this metal recorded in California. As there was only the one producer, the exact figures and value were concealed under the 'unapportioned' item.

The cadmium occurs associated with the zinc sulphide, sphalerite, probably as the sulphide, greenockite. The principal uses of cadmium are in low melting-point, or cliché alloys, and in the manufacture of paint pigments. The cadmium alloys are said to be superior for some purposes to similar bismuth compounds. Cadmium is also used in bronze telegraph and telephone wires.

In the last year of the war (1918), the United States Government[1] and certain large concerns began experiments with cadmium solder as a means of saving tin. The results of these experiments were promising, but the demand for tin decreased, and the armistice was signed before cadmium solders became widely used. Cadmium was used by European nations during the war for some strictly military purposes, but little exact information is available to show those purposes. Germany was the first of the belligerent nations to make large use of cadmium as a substitute for tin in solders, being cut off by the blockade almost entirely from the world's sources of tin.

The average prices of the metal and the sulphide of cadmium in 1919 were $1.22 and $1.20 per pound, respectively, compared with $1.48 and $1.36 in 1918.

COPPER.

Bibliography: State Mineralogist Reports VII, XIII, XIV, XV. Bulletins 23, 50.

Copper is second only to gold among the metals produced in California. For many years, Shasta has been the leading county in the output of the red metal, but in 1919, Plumas advanced to first place. This was due to the maintenance of output level by the Engels and Walker properties in Plumas County, and to the shutting down of the Mammoth and Afterthought properties in Shasta County. Both the Engels and Walker mines have flotation plants in operation, and ship the concentrates to smelters outside of the state. Other important producing counties in 1919 were Calaveras, Siskiyou, San Bernardino, Madera, and Inyo, in the order named.

In 1919, some yield in greater or less amount, was reported from a total of 16 counties as against 24 counties in 1918. The production for the year was 22,162,605 pounds, valued at $4,122,246, which is less than one-half the output of the year 1918. The European war caused a greatly increased demand for copper to make brass shells of all calibers, as well as other requirements. This raised the price from the 1914 average of 13.3¢ to 17.5¢ per pound in 1915; 24.6¢ in 1916;

[1]U. S. G. S. Press Bull. No. 407, May, 1919, p. 1.

27.3¢ in 1917, and 24.7¢ in 1918. The 1919 average dropped to 18.6¢ per pound. Following the signing of the armistice in Europe, the price of copper dropped to 15¢ per pound, and a number of mines curtailed their operations or shut down entirely.

Flotation concentration is now being successfully employed at a number of the copper mines in California, notably by the Engels Copper Company and the Walker Mine in Plumas County, the Calaveras Copper Company in Calaveras County, and the Mammoth Copper Company in Shasta County.

A leaching plant has been built near Raymond to handle ores from the Green Mountain copper mine in Mariposa County. It is proposed to place their product on the market in the form of bluestone, cement copper, and other by-products.

Distribution of the output, by counties, for 1919, was as follows:

County	Pounds	Value
Calaveras	2,049,330	$381,175
Inyo	169,713	31,567
Madera	175,405	32,625
Mariposa	24,879	4,627
Mono	539	100
Plumas	10,193,951	1,896,075
Riverside	10,590	1,970
San Bernardino	256,933	47,790
Shasta	8,673,342	1,613,242
Del Norte, Nevada, Placer, San Diego, Siskiyou, Trinity, Tuolumne*	607,923	113,075
Totals	22,162,605	$4,122,246

*Combined to conceal output of a single operator in each.

Amount and value of copper production in California annually since such records have been compiled by the State Mining Bureau is given in the following tabulation:

Year	Pounds	Value	Year	Pounds	Value
1887	1,600,000	$192,000	1905	16,997,489	$2,650,605
1888	1,570,021	235,303	1906	28,726,448	5,522,712
1889	151,505	18,180	1907	32,602,945	6,341,387
1890	23,347	3,502	1908	40,868,772	5,350,777
1891	3,397,455	424,675	1909	65,727,736	8,478,142
1892	2,980,944	342,808	1910	53,721,032	6,680,641
1893	239,682	21,571	1911	36,838,024	4,604,753
1894	738,594	72,486	1912	34,169,997	5,638,049
1895	225,650	21,901	1913	34,471,118	5,343,023
1896	1,992,844	199,519	1914	30,491,535	4,055,375
1897	13,638,626	1,540,666	1915	40,968,966	7,169,567
1898	21,543,229	2,475,168	1916	55,809,019	13,729,017
1899	23,915,486	3,990,534	1917	48,534,611	13,249,948
1900	29,515,512	4,748,242	1918	47,793,046	11,805,883
1901	34,931,788	5,501,782	1919	22,162,605	4,122,246
1902	27,860,162	3,239,975			
1903	19,113,861	2,520,997	Totals	803,296,203	$134,261,429
1904	29,974,154	3,969,995			

GOLD.

Bibliography: State Mineralogist Reports I to XV (inc.). Bulletins 36, 45, 57. U. S. G. S., Prof. Pap. 73.

Gold is one of the most important mineral products of California. For a number of years up to 1916 there was a marked tendency toward increased activity in gold mining, as investors realized that many of the mines and prospects have not been exhausted. The increase in costs of all supplies, labor and transportation during the past four years has made it increasingly difficult for the gold miner to operate at a profit.

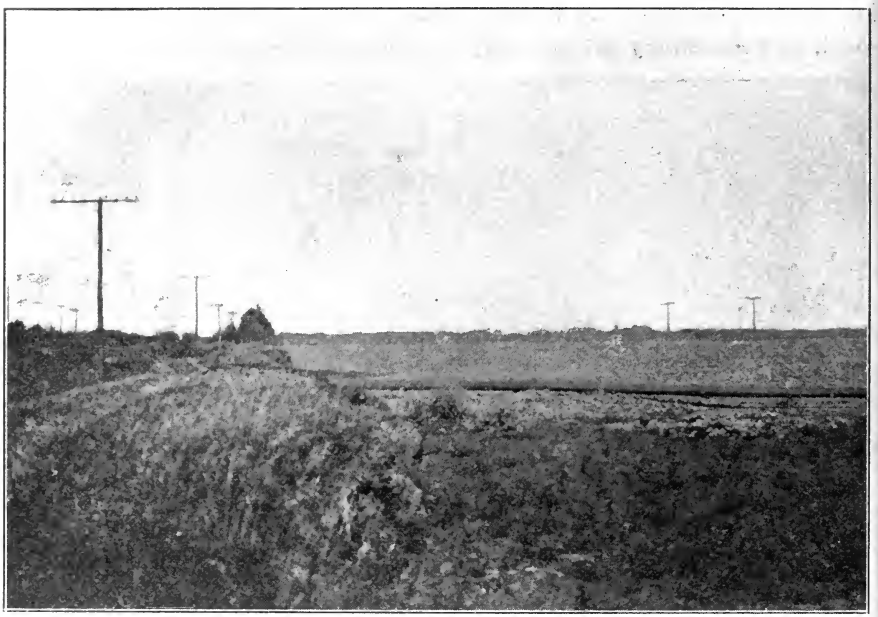
Re-soiling gold dredge of Natomas Company of California, near Natoma, Sacramento County Showing discharge equipment. The coarser material is dropped into deep water, nearest to the boat, the finer material and silt being carried out farther and left on top.

The gold output of not only California, but of the other western gold states has decreased greatly. Many of the mines have been forced to close down.

The gold miner is decidedly at a disadvantage. The prices of other metals and products can be raised to meet conditions; but the gold miner's dollar, being the base, has to remain at the same face value though its purchasing power has dropped to approximately 47%. A bill has been introduced in Congress to provide for a subsidy on new gold produced in the United States. When conditions again

assume a normal trend, gold mining will again increase; but it will probably take several years.

There is one branch of gold mining, however, that has apparently passed its zenith in California—that of dredging. The available ground at Oroville, in Butte County, the oldest field in the state, is nearly worked out. Some re-dredging will be done by larger, modern machines in the earliest ground worked there, but not over the entire



Dredged land as left by the re-soiling dredge shown on preceding page. Contrast these two views with that presented by the photograph shown on page 53, *post,* under Platinum.

area. In May, 1919, there remained but three boats in operation at Oroville.

The State Mining Bureau has never independently collected statistics of gold and silver production, as there is no necessity for duplicating the very thoroughly organized work of the U. S. Geological Survey covering those metals. The data here given relative to these two metals has been received through the courtesy and cooperation of Mr. Charles G. Yale, Statistician in Charge of the San Francisco branch office of the Division of Mineral Resources. Anyone wishing fuller details of the production of these metals may obtain the same by applying to the U. S. Geological Survey, Washington, D. C., or to room 305, U. S. Custom House, San Francisco, California, for a copy of the 'separate' on the subject.

The final figures for the 1919 gold and silver output segregated by counties not being available at the time of compiling the other portions of the present bulletin, it has been deemed best to estimate the gold and silver, and thus avoid delay in issuing the data on the other minerals of California. The delay in compilation of gold and silver figures is due to the necessity of gathering also additional data incident to the Fourteenth Census, by the U. S. Geological Survey in conjunction with the Census Bureau.

There was apparently a slight increase in the 1919 gold output of California, compared to the 1918 yield; but the outlook for 1920 is far from encouraging. Among those that have been large producers, the Argonaut and Kennedy mines in Amador County have been nonproductive for several months on account of a stubborn underground fire and the flooding of the workings to conquer it; and the North Star mine in Nevada County has been working at only part capacity. In addition to these, two of the large copper smelters, the Mammoth and the Mountain, which have yielded important amounts of gold and silver, have been shut down, though the latter is just (July, 1920) resuming.

The following is quoted from the mid-year review by Yale[1], as to conditions during the first 6 months of 1920:

"Numerous properties continue to be operated at a loss, which were profitable under normal conditions. Once shut down and filled with water, such mines may never be reopened, as the cost of rehabilitation is apt to be prohibitive. Two of the most productive mines of the Mother Lode, with workings extending vertically below 4000 feet, had to be flooded to extinguish disastrous fires and now hard and expensive work is being done in unwatering them. This work was commenced as soon as the fire was out to avoid as far as possible caving and destruction of timber. On the Mother Lode five or six years ago they could make a profit on $3.50 ore but now nothing can well be classed as ore under $6 per ton value. Not only the quartz but the placer field also is affected. One large dredging company, handling about 36,000,000 tons of gravel yearly, six years ago worked 14 dredges which dug up $2,637,700 in gold at a cost of $15 per fine ounce. Last year they worked 11 dredges and their gold output of $1,840,000 cost $23 per fine ounce. It is found less costly to absorb the loss than to close down the plant, for taxes, insurance, deterioration of equipment, and breaking up of organization would be greater than this present loss.

"During the first six months of 1920 the United States Mint and local smelters and refiners, to which most of the newly mined gold from California is sent, received from the mines of the state $7,811,390 in gold, or $1,086,739 less than during the first six months of 1919. For the same period these institutions received 503,794 ounces of silver, or 376,310 ounces more than in the first half of 1919. These figures show a loss in 1920 for the period named of 12 per cent in gold and a gain of 284 per cent in silver output. This abnormal increase in silver is due entirely to the operations of a newly-discovered silver mine in San Bernardino County, just over the border of Kern County. The loss in gold is caused by cessation or curtailment of operations in certain large mines on the Mother Lode and elsewhere and the stoppage of work on numbers of smaller mines, owing to high costs of supplies and costs of and scarcity of skilled labor.

"In 1918 there was a falling off in California in the production of gold, compared with 1917, of over $3,500,000 for the year; but in 1919, with an estimated production of $17,380,000, there was a gold increase of $852,000 over 1918, which showed some recovery toward normal output, as predicted in the midyear review of 1919. However, if the monthly receipts at the mints, smelters, and refineries for the last six months of 1920 keep up the same ratio as in the first six months, the total California gold output for 1920 should be $15,622,000, or $1,758,000 less than in 1919. It is probable that some such deficit will be shown when the final figures are compiled, as the existing conditions in the gold-mining industry of the state continue to be exceedingly unfavorable to even normal production. Most of the California silver is

[1]Yale, C. G., Press Bulletin, U. S. G. S., July, 1920.

obtained in the mining of gold, copper and lead ores, as a secondary product, for there are very few purely silver mines being operated in the state. Within the past year, however, a number of old silver mines have been started up again, owing to high prices of the metal. These are mainly in the southern portion of the state, where one, discovered in 1919, continues to make a high monthly production.

"At Grass Valley, the most important of the quartz mining districts of the state, the larger mines are affected by a shortage of skilled miners. Higher wages in lumber camps and shipyards have induced many to give up mining work. The Empire mines, the most productive of the deep-gold mines of the state, has made many extensive improvements this year and has an 80-stamp mill instead of the two on the Empire and Pennsylvania claims. The North Star at the same place continues production but at a lesser rate than during normal times. At Jackson and Sutter Creek, Amador County, the most productive district in the Mother Lode, the principal producers have made little output this year, owing to the necessity of unwatering the mines after flooding them to extinguish fire. The highly productive activities of the recently reopened Morgan mine, Calaveras County, are noteworthy.

"Shortage of water throughout the hydraulic mining regions in Sierra, Plumas, Siskiyou, Trinity, and other counties, where this class of work is carried on, has greatly reduced gold production from this source. Drift mining has also languished and no new properties of note have been opened. The dredge mining industry has probably suffered less than other gold producing activities, yet skilled labor has been scarce and high costs with reduced values of product have materially lessened output and profits.

"The copper mining interests of California have not been in a satisfactory condition this year. What was formerly the largest producer, the Mammoth, of Shasta County, continues entirely closed down with its furnaces at Kennett cold. The Afterthought property has suspended work and drawn its pumps, awaiting a rise in the price of copper. The Bully Hill has recently been sold and has been for sometime unproductive. The Mountain Copper Company, at Keswick, started work again this year in its Iron Mountain and Hornet mines and is reducing its ore at the smelters on San Francisco Bay. There has been curtailment of operations at the mines of both the Calaveras Copper and Penn mining companies in Calaveras County. Plumas is now the most productive of the copper-mining counties of the state and new activities are apparent, while the principal mines, the Engels and Walker, continue productive and have made many permanent improvements at ther respectve plants.

"The favorable price of silver and lead ores has led to the reopening of numbers of old silver-lead-zinc properties in Inyo and San Bernardino counties and encouraged the development of many prospects. The Cerro Gordo near Keeler, the most productive of the lead-zinc mines, has been started up again and ore shipments are being made by the Rip Van Winkle, Lucky Jim, Utacala, Sterling, and other mines around Darwin. Most of the zinc of California in 1920 will come from these southern counties, as very little has been produced in Shasta County."

The estimate of $17,320,250 by Yale[1] for the gold output of California for 1919 was based on the U. S. Mint and the smelter receipts for fifty weeks, with an estimate of the last two weeks based on the percentage which the December yield of 1918 bore to the whole product of that year. This system of calculation has been found to give a close approximation to the actual results. Using the above as a basis, coupled with data from field operations of various members of the staff of the State Mining Bureau, and a comparison of the figures of platinum production in hand, the author has made the estimated segregation herewith of the 1919 gold output by counties. The estimate is made in order to facilitate publication of the other portions of the present report, for the reasons shown in a preceding paragraph.

[1]Yale, C. G., Press Bulletin, U. S. G. S., January, 1920.

The estimated gold production of California for 1919 was distributed, by counties, as follows:

County	Value	County	Value
Amador	$3,200,000	Plumas	$130,000
Butte	700,000	Riverside	400
Calaveras	1,410,000	Sacramento	1,820,000
Del Norte	500	San Bernardino	25,000
El Dorado	28,000	Shasta	525,000
Fresno	5,000	Sierra	290,000
Humboldt	8,000	Siskiyou	350,000
Imperial	200	Trinity	500,000
Inyo	90,000	Tuolumne	250,000
Kern	230,000	Yuba	3,875,000
Madera	8,000	Modoc, San Joaquin, San Diego, Stanislaus*	230,000
Mariposa	400,000		
Mono	30,000		
Nevada	3,000,000	Total value	$17,335,100
Placer	230,000		

*Combined to conceal output of a single operator in each.

Total Gold Production of California.

The following table was compiled by Chas. G. Yale, of the Division of Mineral Resources, U. S. Geological Survey, but for a number of years statistician of the California State Mining Bureau and the U. S. Mint at San Francisco. The authorities chosen for certain periods were: J. D. Whitney, state geologist of California; John Arthur Phillips, author of "Mining and Metallurgy of Gold and Silver" (1867); U. S. Mining Commissioner R. W. Raymond; U. S. Mining Commissioner J. Ross Browne; Wm. P. Blake, Commissioner from California to the Paris Exposition, where he made a report on "Precious Metals" (1867); John J. Valentine, author for many years of the annual report on precious metals published by Wells, Fargo & Company's Express; and Louis A. Garnett, in the early days manager of the San Francisco refinery, where records of gold receipts and shipments were kept. Mr. Yale obtained other data from the reports of the director of the U. S. Mint and the director of the U. S. Geological Survey. The authorities referred to, who were alive at the time of the original compilation of this table in 1894, were all consulted in person or by letter by Mr. Yale with reference to the correctness of their published data, and the final table quoted was then made up.

The figures since 1904 are those prepared by the U. S. Geological Survey:

Year	Value	Year	Value
1848	$245,301	1885	$12,661,044
1849	10,151,360	1886	14,716,506
1850	41,273,106	1887	13,588,614
1851	75,938,232	1888	12,750,000
1852	81,294,700	1889	11,212,913
1853	67,613,487	1890	12,309,793
1854	69,433,931	1891	12,728,869
1855	55,485,395	1892	12,571,900
1856	57,509,411	1893	12,422,811
1857	43,628,172	1894	13,923,281
1858	46,591,140	1895	15,334,317
1859	45,846,599	1896	17,181,562
1860	44,095,163	1897	15,871,401
1861	41,884,995	1898	15,906,478
1862	38,854,668	1899	15,336,031
1863	23,501,736	1900	15,863,355
1864	24,071,423	1901	16,989,044
1865	17,930,858	1902	16,910,320
1866	17,123,867	1903	16,471,264
1867	18,265,452	1904	19,109,600
1868	17,555,867	1905	19,197,043
1869	18,229,044	1906	18,732,452
1870	17,458,133	1907	16,727,928
1871	17,477,885	1908	18,761,559
1872	15,482,194	1909	20,237,870
1873	15,019,210	1910	19,715,440
1874	17,264,836	1911	19,738,908
1875	16,876,009	1912	19,713,478
1876	15,610,723	1913	20,406,958
1877	16,501,268	1914	20,653,496
1878	18,839,141	1915	22,442,296
1879	19,626,654	1916	21,410,741
1880	20,030,761	1917	20,087,504
1881	19,223,155	1918	16,529,162
1882	17,146,416	1919	*17,335,100
1883	24,316,873		
1884	13,600,000	Total	$1,706,546,203

*Estimated.

IRIDIUM (see under Platinum).

IRON ORE.

Bibliography: State Mineralogist Reports II, IV, V, X, XII, XIII, XIV, XV. Bulletins 38, 67. Am. Inst. Eng., Trans. LIII. Min. & Sci. Press, Vol. 115, pp. 112, 117–122.

Iron ore to the amount of 2,300 tons, valued at $13,796, was produced in California during the year 1919, and utilized for foundry flux.

There are considerable deposits of iron ore known in California, notably in Shasta, Madera, Placer, Riverside and San Bernardino counties, but production has so far been limited, on account of our having no economic supply of coking coal. Some pig-iron has been made, utilizing charcoal for fuel, both in blast furnaces and by electrical

reduction. Further developments along the line of electrical smelting, or discoveries making available our petroleum fuel, for iron reduction, would lead to considerable increase of iron mining in California. For the present, at least, the most feasible possibilities lie in utilizing our iron resources in the preparation of the various alloys such as ferro-chrome, ferro-manganese, ferro-molybdenum, ferro-silicon and ferro-tungsten, by means of the electric furnace. California possesses commercial deposits of ores of all of the metals just enumerated.

Total iron ore production in the state, with annual amounts and values, is as follows:

Year	Tons	Value	Year	Tons	Value
1881*	9,273	$79,452	1910	579	$900
1882	2,073	17,766	1911	558	558
1883	11,191	106,540	1912	2,508	2,508
1884	4,532	40,983	1913	2,343	4,485
1885			1914	1,436	5,128
1886	3,676	19,250	1915	724	2,584
1887			1916	3,000	6,000
1893	250	2,000	1917	2,874	11,496
1894	200	1,500	1918	3,108	15,947
1895			1919	2,300	13,796
1907	400	400			
1908			Totals	51,113	$431,467
1909	108	174			

*Productions for the years 1881-1886 (inc.) were reported as "tons of pig iron," (U. S. G. S., Min. Res. 1885), and for the table herewith are calculated to "tons of ore" on the basis of 47.6% Fe as shown by an average of analysis of the ores (State Mineralogist's Report IV, p. 242). This early production of pig iron was from the blast furnaces then in operation at Hotaling in Placer County. Charcoal was used in lieu of coke. Though producing a superior grade of metal, they were obliged finally to close down, as they could not compete with the cheaper English and eastern United States iron brought in by sea to San Francisco.

LEAD.

Bibliography: State Mineralogist Reports IV, VIII, X, XV.

Lead production in California in 1919 fell off to less than one-third that of the preceding year, both in quantity and value. The average price dropped from 8.6¢ in 1917 to 7.1¢ per pound in 1918; and to 5.3¢ in 1919; which, however, is still above the pre-war prices of 3.9¢ in 1914 and 4.7¢ in 1915.

The principal production in this state comes from Inyo County, which contributed 89% of the 1919 yield, followed by Shasta and San Bernardino in the order named.

County	Pounds	Value
Calaveras	2,019	$107*
Inyo	3,643,485	193,105*
Mono	1,556	82*
San Bernardino	105,796	5,607*
Imperial, Mariposa, Nevada, Orange, Riverside, Shasta*	386,706	20,496
Totals	4,139,562	$219,397

*Combined to conceal output of a single operator in each.

Statistics on lead production in California were first compiled by this Bureau in 1887. Amount and value of the output, annually, with total figures, to date, are given in the following table:

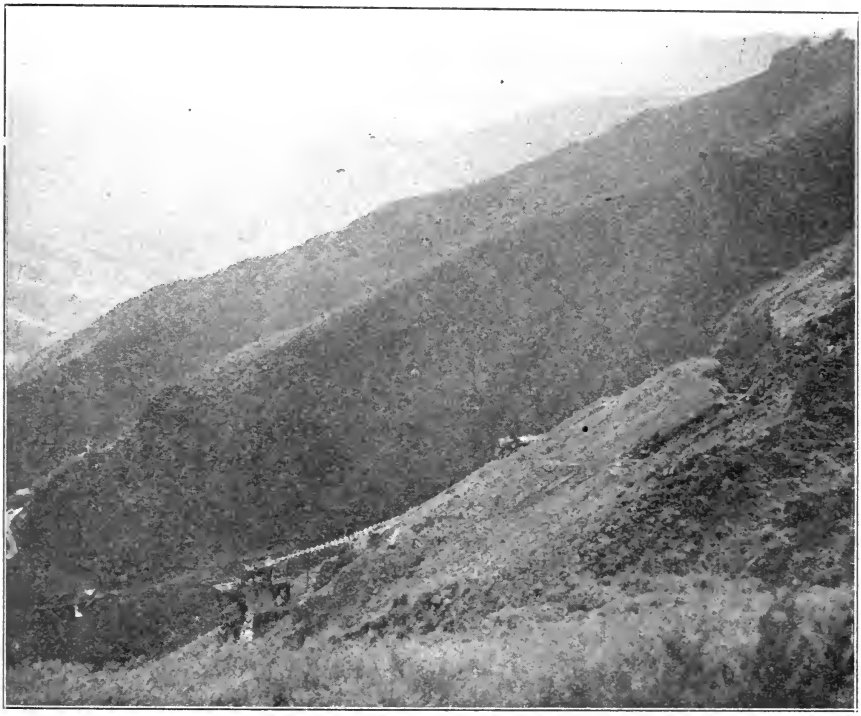
Year	Tons	Value	Year	Tons	Value
1887	580	$52,200	1905	266	$25,083
1888	450	38,250	1906	169	19,307
1889	470	35,720	1907	164	16,690
1890	400	36,000	1908	562	46,663
1891	570	49,020	1909	1,343	144,897
1892	680	54,400	1910	1,508	134,082
1893	333	24,975	1911	701	63,173
1894	475	28,500	1912	685	61,653
1895	796	49,364	1913	1,820	160,202
1896	646	38,805	1914	2,349	183,198
1897	298	20,264	1915	2,398	225,426
1898	328	23,907	1916	6,196	855,049
1899	360	30,642	1917	10,826	1,862,016
1900	520	41,600	1918	6,732	956,006
1901	360	28,820	1919	2,070	219,397
1902	175	12,230			
1903	55	3,960	Totals	45,347	$5,546,769
1904	62	5,270			

MANGANESE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletins 38, 67, 76. U. S. G. S., Bull. 427.

In the statistical reports previous to 1915, manganese ore was included in the 'industrial materials' list. In that year we made a transfer, and have since placed it under 'metals,' because by far the greater tonnage of manganese ore is utilized in the preparation of ferro-manganese and employed in the steel industry both for its metal content and to slag off certain impurities during the open-hearth treatment. Though its other uses may be classed at 'chemical,' the tonnage thus consumed is relatively smaller. Its chemical uses are as a decolorizer or oxidizer in glass manufacture, and as a constituent in electric dry batteries. The chemical uses require a much higher grade of ore than the steel industry. For steel purposes an iron content is acceptable, but manganese should exceed 40%. Silica should be under 8%, though higher has been taken during the recent increased demand. Phosphorus should be under 0.20%. For electric dry cells, the iron content should be under 1.5% Fe_2O_3, and SiO_2, under 6%. For glassmaking the manganese should be practically free of iron. On account of the high prices prevailing for manganese during the past three years, it is stated that selenium was replacing it, in part at least, in glass factories.

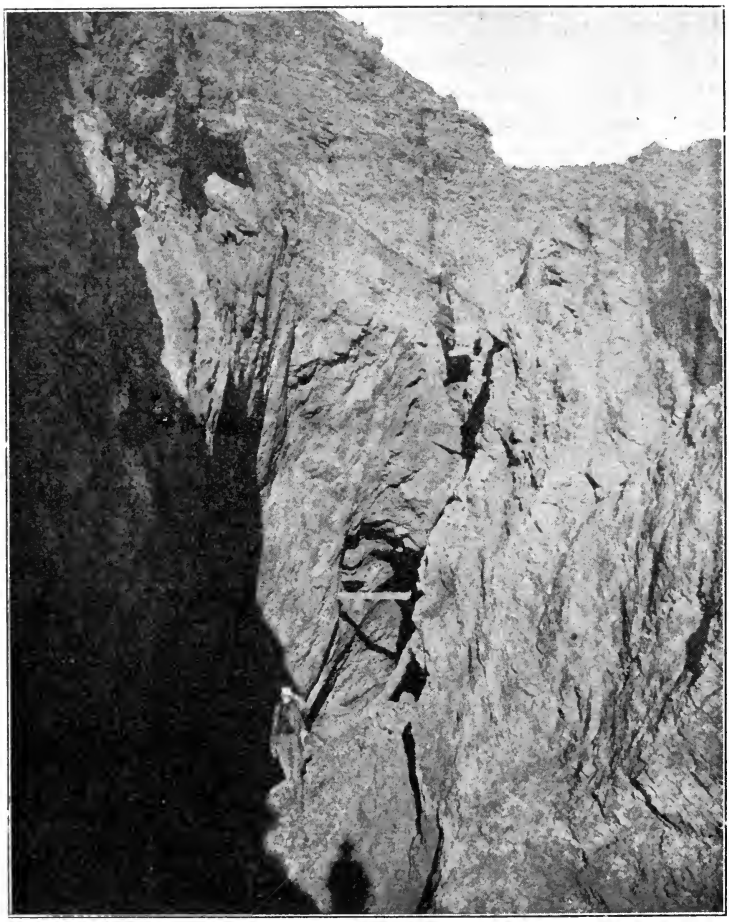
Though the imports of manganese ore from the Caucasus district in Russia were reduced by the war to practically nothing (about 1% of 1914 figures), the United States received important shipments from Brazil, India and Cuba; so that the total imports for 1916 were practically double those of either 1914 or 1915. The 1916 figures were 576,321 long tons, valued at $8,666,179; for 1917, a total of 629,972 long tons, valued at $10,262,929, of which 512,517 tons were from Brazil; in 1918 a total of 491,303 long tons, value $15,095,867, of which



Buckeye Manganese Mine, west of Vernalis, Stanislaus County. An important producer in 1918-1919. Open cut at right; aerial tramway at left.

345,877 tons were from Brazil; in 1919, a total of 333,344 long tons, value $11,229,184, of which 246,592 tons came from Brazil. The increased demand for steel products increased the necessity for ferro-manganese, which is used largely in the open-hearth process of steel making. This resulted in curtailment of ferro-manganese exports from England, and the resulting shortage in the United States was met by the greater imports of manganese ore from Brazil especially, and an increased domestic production both of ore and ferro-manganese. These conditions caused the prices for the ores to range from $30 to $60

per ton, f.o.b. rail, California, for the steel grades, to above $75 for chemical grades, during 1918.



Open-cut stope of Buckeye Manganese Mine, Stanislaus County. Ore body extracted was 20′ wide and over 75′ long, of ore carrying 48% manganese.

Reports received by the Survey[1] from makers of manganese alloys—ferro-manganese and spiegeleisen—

"indicate that 35 per cent of the metallic manganese used in the alloys made and imported during 1918 was derived from ores mined in the United States. As the proportion of domestic manganese in such alloys was only 4 per cent in 1913 and 16 per cent in 1916 the domestic miners of manganese made a notable contribution to the nation's independence in mineral supplies in war time. Had the war continued for another year domestic ores would probably have supplied half the manganese in the manganese alloys needed by the country."

[1]U. S. Geol. Surv., Press Bulletin No. 414, July, 1919, p. 1.

Batteries, chemicals, and kindred industries in the United States consume approximately 25,000 tons of high-grade manganese ore, annually, or about one-thirtieth of that used in steel manufacture.

A considerable portion of the state's 1917 and 1918 product was utilized in California in making ferro-manganese by electric furnace; besides shipments which were sent East. Some 'chemical' ore was also shipped. For many years the principal producing section has been the Livermore-Tesla district, in Alameda and San Joaquin counties, but exceeded in 1915 by Mendocino and regaining the lead in 1916.

Manganese Mine on Sec. 19, T. 5 S., R. 6 E., M. D. M., Stanislaus County. (Cummings Lease.)

In 1918–1919 the largest producing county was Stanislaus, which adjoins San Joaquin on the south, and whose manganese district is a part of the same geological province that includes the Livermore-Tesla district.[1] Manganese is reported to exist in many localities in the state; but for a number of years, particularly since the discontinuance of the chlorination process in the metallurgy of gold, production was relatively unimportant until the activity of the war period just closed.

The production of manganese ore in California for 1919 amounted to 11,569 tons of all grades, having a total value of $451,422 f.o.b. railway shipping point. This is a decrease of more than 50% both in quantity

[1]See Plate II, p. 24, Cal. State Min. Bur. Bulletin No. 76, 1918.

and value from the 1918 figures. The 1916 output nearly equaled the entire previous tonnage, 1887 to 1915, and was about double the value for the same period. Most of the 1919 output of California manganese was made during the first half of the year by a few companies who had uncompleted contracts running to July 1. Since the first of the present year (1920) the market has revived and several properties are being reopened both in the Mendocino and the San Joaquin-Stanislaus

Near view of stope on Cummings Lease Manganese Mine, Stanislaus County.

districts. The following quotations have recently (June 24, 1920) been offered:

44% — 49.99% Mn @ 76¢ per unit.
50% — 52% Mn @ 80¢ per unit.
52% and up Mn @ 82¢ per unit.

The 1919 output was distributed by counties as follows:

County	Tons	Value
Riverside	1,808	$49,324
San Joaquin	343	10,274
Santa Clara	102	3,321
Stanislaus	8,921	374,584
Alameda, Amador, Los Angeles, Plumas, San Luis Obispo*	395	13,919
Totals	11,569	$451,422

*Combined to conceal output of a single operator in each.

In 1918 there were two electric smelters in operation in California making ferro-alloys: the plant of the Noble Electric Steel Company at Heroult, Shasta County, and the newer one of the Pacific Electro Metals Company at Bay Point, Contra Costa County. Both were idle in 1919.

Production of manganese ore in California began at the Ladd Mine, San Joaquin County, in the Tesla District in 1867. When shipments of this ore to England ceased late in 1874, upwards of 5,000 tons had been produced by that property. For some years following that, the output was small. The tabulation herewith shows the California output of manganese ore, annually, since 1887, when the compilation of such figures was begun by the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1887	1,000	$9,000	1905		
1888	1,500	13,500	1906	1	$30
1889	53	901	1907	1	25
1890	386	3,176	1908	321	5,785
1891	705	3,830	1909	3	75
1892	300	3,000	1910	265	4,235
1893	270	4,050	1911	2	40
1894	523	5,512	1912	22	400
1895	880	8,200	1913		
1896	518	3,415	1914	150	1,500
1897	504	4,080	1915	4,013	49,098
1898	440	2,102	1916	13,404	274,601
1899	295	3,165	1917	15,515	396,659
1900	131	1,310	1918	26,075	979,235
1901	425	4.405	1919	11,569	451,422
1902	870	7,140			
1903	1	25	Totals	80,202	$2,240,816
1904	60	900			

MOLYBDENUM.

Bibliography: Report XIV. Bulletin 67. U. S. Bur. of Min., Bulletin 111. Proc. Colo. Sci. Soc., Vol. XI.

Molybdenum is used as an alloy constituent in the steel industry, and in certain forms of electrical apparatus. Included in the latter, is its successful substitution for platinum and platinum-iridium in electric contact-making and breaking devices. In alloys it is used similarly to and in conjunction with chromium, cobalt, iron, manganese, nickel, tungsten, and vanadium. The oxides and the ammonium salt have important chemical uses.

The two principal molybdenum minerals are: the sulphide, molybdenite; and wulfenite, lead molybdate, the former furnishing practically the entire commercial output. Molybdenite is found in or associated with acidic igeneous rocks, such as the granites and pegamatites. The chief commercial sources have been New South Wales, Queensland, and Norway, with some also from Canada.

Deposits of disseminated molybdenite are known in several localities in California, and in at least two places it occurs in small masses associated with copper sulphides. In 1916, was recorded the first commercial shipments of molybdenum ore in California.

The 1917 output included some concentrates assaying up to 58% MoS_2, but the bulk of it was 1.5% ore which was shipped to Denver, Colorado, for concentration. That production came mainly from Shasta County, with smaller amounts from Inyo, Mono and San Diego counties. There were two concentrating plants built in California—one in each of the above first and last-named counties.

In 1917 the plant of the Sacramento Mining Company, lessee, at the Bour mine near Ramona, San Diego County, made a small output of concentrates; but the mine has since reverted to the owner, and the plant dismantled.

In the spring of 1918, a flotation plant operated for a short time by a lessee on the Boulder Creek mine, near Gibson Siding, Shasta County, made a small amount of 90% MoS_2 concentrate. The ore treated carried 2.6% MoS_2. There was none produced in 1919.

The California production of molybdenum ore by years is summarized in the following tabulation:

Year	Tons	Value
1916	8	$9,945
1917	243	9,014
1918	*	*
Totals	251	$18,959

*Concealed under 'Unapportioned.'

NICKEL.

Bibliography: Report XIV. U. S. G. S., Bulletin 640-D.

Nickel occurs in the Friday Copper Mine in the Julian District, San Diego County. The ore is a nickel-bearing pyrrhotite, with some associated chalcopyrite. Some ore has been mined during recent years in the course of development work, but not treated nor disposed of, as they are as yet unable to get any smelter to handle it for them. Nickel ore has also been reported from Siskiyou County, west of Gazelle and from San Bernardino County.

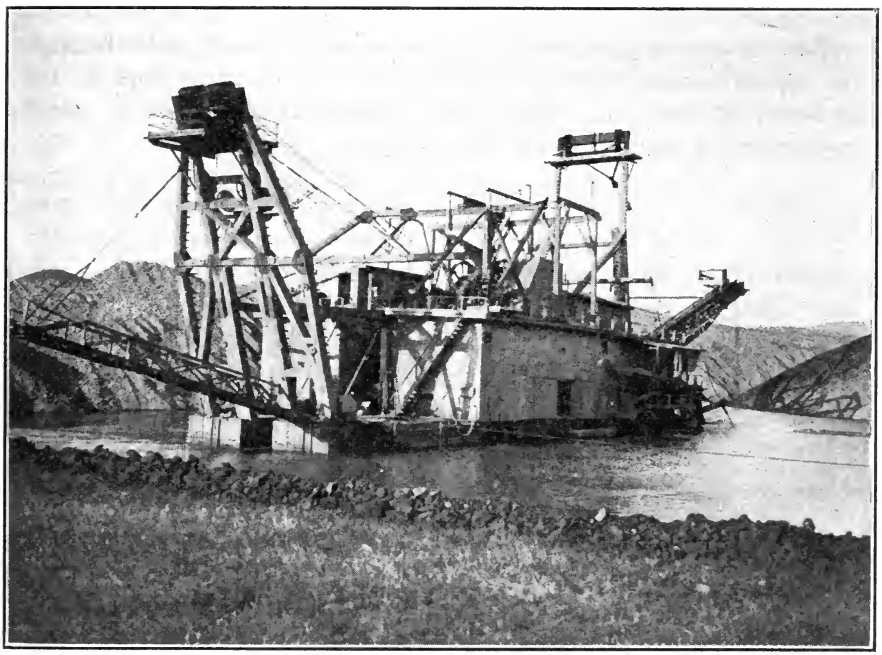
OSMIUM (see under Platinum).

PALLADIUM (see under Platinum).

PLATINUM.

Bibliography: State Mineralogist Reports IV, VIII, IX, XII, XIII, XIV, XV. Bulletins 38, 45, 67, 85. U. S. G. S., Bull. 285.

In California platinum is obtained as a by-product from placer operations for gold. The major portion of it comes from the dredges operating in Butte, Calaveras, Sacramento and Yuba counties, while the hydraulic and surface sluicing mines of Del Norte, Humboldt, Siskiyou



Dredge No. 11 of the Natomas Company near Folsom, Sacramento County. Of the platinum produced in California in 1919, the gold dredges yielded 92 per cent. Compare these tailings piles with those shown in the photographs on pp. 39, 40, *ante*.

and Trinity and the dredges of Merced and Stanislaus yield a smaller amount.

The production for 1919 amounted to 610 ounces of crude platinum-group metals, containing 418 fine ounces, valued at $60,611. Of this amount a total of 398 ounces, crude, or 92%, came from the gold dredges. Crude platinum varies considerably in its purity. That marketed in recent years[1] has averaged around 51% platinum, 3% iridium, and 30% osmiridium or iridosmine. Some platinum is also recovered in the electrolytic refining of blister copper. It has been found[2] that blister copper from several smelters in the United States carries from 0.342 oz. to 1.825 oz. platinum and from 0.607 oz. to

[1]U. S. G. S., Min Res., 1914, Pt. I, p. 336.
[2]Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217-218, 1913.

4.402 oz. palladium per 100 tons of blister copper treated. That from Iron Mountain, Shasta County, California, also yields some platinum. Iron in greater or less amount is always alloyed naturally with native platinum, and usually some iridium and osmium.

For further detailed information on California's platinum resources, analyses, tests, et al., the reader is referred to Bulletin 85, recently issued by the State Mining Bureau.

In addition, there is usually some platinum recovered as a by-product in the gold refinery of the Mint, but which can not be assigned to the territory of its origin for lack of knowing to which lots of gold it belongs. The San Francisco Mint is stated to have recovered as high as 100 ounces of platinum in a single year from this source, some of which unquestionably came from California mines.

"United States refiners of gold and copper produce annually about 1,500 ounces of refined platinum as a by-product, chiefly from copper ore, of both foreign and domestic origin."[1]

For 1919, the distribution by counties was as follows:

County	Fine ounces	Value
Butte	33	$5,071
Calaveras	8	1,076
Shasta	121	21,075
Siskiyou	7	1,015
Yuba	[2]125	13,098
Amador, Mendocino, Nevada, Sacramento, San Joaquin, Stanislaus, Trinity[3]*	124	19,276
Totals	418	$60,611

[2]Includes some palladium.
[3]The fine ounces of metal contained in the Trinity County product was 38 per cent iridium and 62 per cent platinum, for which was received $176 per fine ounce, yielding an average of $103 per ounce of crude material as shipped.
*Combined to conceal output of a single operator in each.

Russia, previous to the war, was producing from 90% to 95% of the world's platinum; but, since 1916 has been reduced to practically nothing.

The price of the metal consequently rose to over $100 per troy fine ounce. During 1916, it varied from $90 in January, to $55 in August, $105 December 1, and closing the year at $82. The 1917 price was from $100 to $105. In 1916, the miners of California received from $43 to $76 per ounce for their crude platinum, and an average of $45.50, as against $29 to $38 per ounce during 1915. In 1917, they received an average of $72 per ounce, and $74.50 in 1918 for crude. During 1918 the U. S. Government commandeered all new platinum produced at a fixed price of $105 per fine ounce. The refiners were licensed and were required to turn over all stocks to the Government. Osmium

[1]Hill, J. M., Our mineral supplies. Platinum: U. S. Geol. Surv., Bulletin 666-D,

was quoted at $35 to $40 per ounce, and iridium at $175. Osmiridium is a natural alloy of the two. In 1919, the prices reached $165 per fine ounce for platinum, and $290 per fine ounce for iridium.

Next in importance to Russia as a producer of platinum is Colombia. California is the leading producer in the United States. There have been occasional reports of platinum in California being found in vein materials, but as yet no authentic case has come to the notice of the laboratory of the State Mining Bureau. The latest reported occurrence is in association with lead carbonate in San Berndardino County. As platinum and chromite are alike in their association wth serpentine derived from basic igneous rocks such as peridotite, pyroxenite and dunite, it is not unlikely that some day platinum will be found in place in some of California's abundant, chrome-bearing serpentine areas. Platinum and chromite have been found intergrown in dunite on the Tulameen River in British Columbia.

Besides its well-known uses in jewelry, dentistry and for chemical-ware, an important industrial development of recent years employs platinum as a catalyzer in the 'contact process' of manufacturing concentrated sulphuric acid. It is also necessary for certain delicate parts of the ignition systems in automobiles, motor boats, and aeroplanes. Experiments have been made to find alloys which can replace platinum for dishes and crucibles in analytical work, but so far with only slight success.

The annual production and value since 1887, have been as follows:

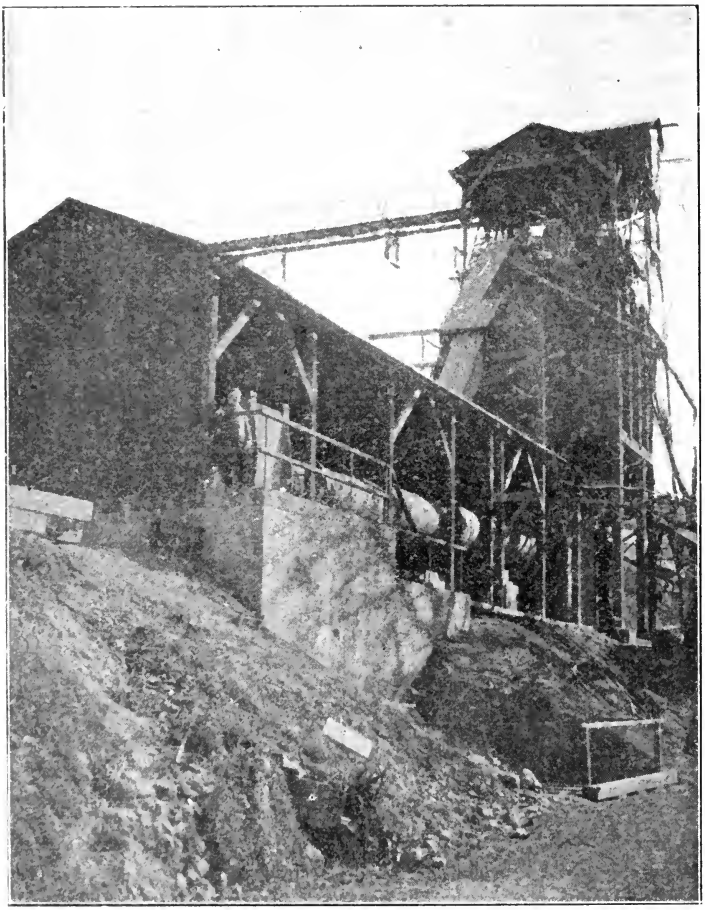
Year	Ounces	Value	Year	Ounces	Value
1887	100	$400	1905	200	$3,320
1888	500	2,000	1906	91	1,647
1889	500	2,000	1907	300	6,255
1890	600	2,500	1908	706	13,414
1891	100	500	1909	416	10,400
1892	80	440	1910	337	8,386
1893	75	517	1911	511	14,873
1894	106	600	1912	603	19,731
1895	150	900	1913	368	17,738
1896	162	944	1914	463	14,816
1897	150	900	1915	667	21,149
1898	300	1,800	1916	886	42,642
1899	300	1,800	1917	610	43,719
1900	400	2,500	1918	571	42,788
1901	250	3,200	1919	*418	60,611
1902	39	468			
1903	70	1,052	Totals	11,140	$345,859
1904	123	1,849			

*Fine ounces.

QUICKSILVER.

Bibliography: State Mineralogist Reports IV, X, XII, XIII, XIV, XV. Bulletins 27, 78. U. S. G. S., Monograph XIII.

Quicksilver was produced in 12 counties in 1919, to the amount of 15,200 flasks, valued at $1,353,381, which is a decrease both in number



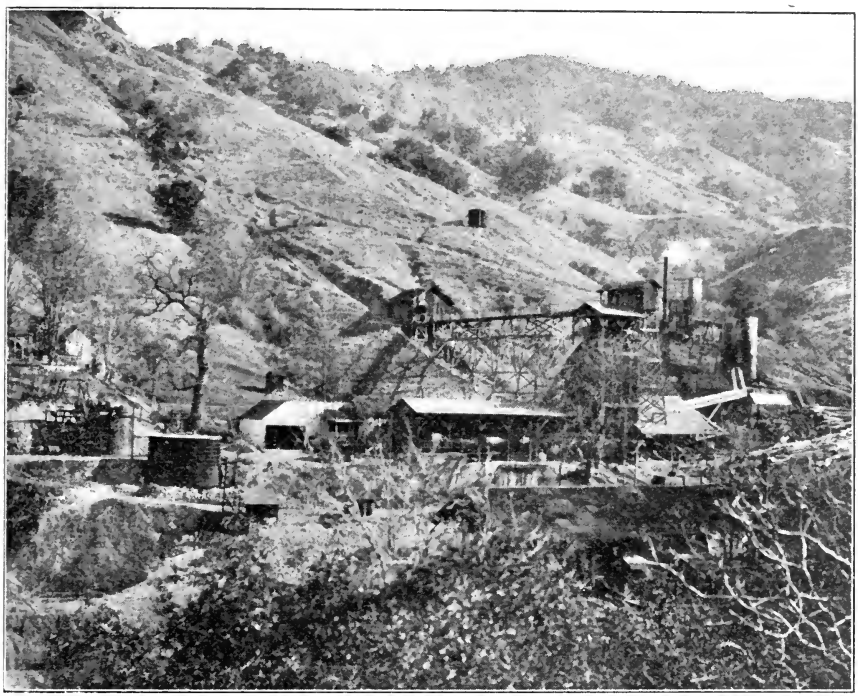
Rotary, quicksilver furnace at Cloverdale Mine, Sonoma County.

of flasks and value compared with the year 1918. The average price received during 1919, according to the producers' reports to the State Mining Bureau, was $89.04, as against the record price of $114.03 in 1918.

Prices.

The following table of monthly San Francisco quotations per flask of 75 pounds, will indicate the status of quicksilver during the year 1919, as compared with the pre-war price of about $37 per flask. San Fran-

cisco is the primary domestic market for quicksilver. The 1914 quotations averaged $49.05 per flask. However, because since the war there has been speculation in quicksilver by parties other than the actual producers, and the price changes have often been rapid so that quotations did not always mean sales, we have since 1914 taken for the average value the average actual sales as reported to us by the producers.



New reduction plant of the Western Mercury Company at the Cloverdale Mine, Sonoma County. Rotary furnace in center. Site of old Livermore furnace under shed in foreground. Incline tramway on surface of hill at left.

This gives us an average value of $81.52 per flask for the year 1915, instead of the $85.80 average of quotations; for 1916, $93.50 instead of $125.89; for 1917, $98.29 instead of $106.33; for 1918, $114.03 instead of $117.50, and for 1919, $89.04 instead of $90.29. From this, it will be seen that the speculative element in the quicksilver market has practically disappeared since the close of the war.

San Francisco Quotations of Quicksilver, 1919.

Month	Average price	Month	Average price
January	$103 75	July	$100 00
February	90 00	August	103 00
March	72 80	September	102 60
April	73 12	October	86 00
May	84 80	November	78 00
June	94 90	December	95 00

The decline in the price, following the armistice in Europe, continued to a low level of $72.80 average for the month of March, 1919. At present writing (July 17, 1920) the quotation is $85 per flask.

Present Economic Situation.

The famous mines at Almaden, Spain, are the largest world producers. These mines are owned by the government and operated by contractors using convict labor. The cost of production of quicksilver is stated to have increased from $8.29 a flask in 1900 to $15.22 in 1915. Their ore is high-grade, the material sent to the furnaces averaging 9%-11% mercury.

For two or three years previous to the outbreak of the European war, our normal peace-time consumption of quicksilver in the United States was approximately 25,000 flasks annually; and our domestic production had fallen below 20,000 flasks per year. Of this 25,000-flask peace-time consumption, nearly 50% went into the manufacture of fulminate for explosive caps for mining, quarrying, and sporting arms ammunition as well as military ammunition. Our domestic production being inadequate, partly because of the low price and the lower average tenor of the ores mined, necessitated the importation of up to 5000 flasks annually. The enormous increase in munitions manufacture due to the war temporarily raised our requirements correspondingly.

There were no imports of quicksilver into the United States for the year 1919. The exports (mainly to the Orient) were 9107 flasks valued at $817,428 for the year.

The import duty of 10% *ad valorem* is not sufficient to protect our American miners against the competition of the convict-operated mines of Spain where quicksilver can be produced for as low as $8 to $15 per flask, as noted above. The duty should be at least $25 per flask to give us proper protection. The improvement in the price increased the number of operating properties in California during 1916–1918. Lower grade ores are being worked; and new methods of ore dressing and reduction have been tried.

Following the signing of the armistice, all but about five of California's mines were closed, owing to the uncertainty of the future. The industry here is in danger of extinction due to the prospect of dumping from Europe, because we have not sufficient tariff protection.

There are those who have taken the position that we should buy where we can get the metal the cheapest, and let our own industry "go hang," as "it is decadent" anyway. That is certainly not a patriotic attitude; nor a safe one either. Though its total value may be small, as compared with such as gold or copper, yet our American (which means mainly, California) quicksilver business has been an important and vital industry for about 70 years. A quicksilver mine can not be

left idle "in reserve" and then opened up at a moment's notice for an emergency.

If, and when, our American quicksilver industry is extinguished by lower-priced foreign competition, we will then be at their mercy, and they can later raise their price to any figure they want and we'll have to pay it. It is not fair to our American capital invested, nor to our California miners (also Nevada and Texas) not to be given protection against the convict-operated and other cheap-labor mines of Spain, Italy and Mexico.

The meat of the situation is summarized by the Tariff Commission in the following:[1]

"In the case of quicksilver, the question can be squarely raised as to whether the production of this metal can be considered an effective American industry, inasmuch as abundant, cheaper sources of supply exist elsewhere. It is particularly an example of an industry whose products are placed on the market at high cost because of the relatively inferior natural resources of this country in the raw material.

"Quicksilver is an essential metal, however, of vital necessity in the conduct of war and widely used in the industries. It is stated that American resources, although low grade, can furnish an adequate supply for many years if a stable and sufficient price be guaranteed. Without tariff protection the United States will be dependent in large part on outside sources for a vital commodity, and a grave question of national expediency is involved."

In the opinion of the quicksilver men, and the writer, the last sentence, above, is the most important of all.

Uses.

The most important uses of quicksilver are the recovery of gold and silver by amalgamation, and in the manufacture of fulminate for explosive caps, of drugs, of electric appliances, and of scientific apparatus. By far the greatest consumption is in the manufacture of fulminate and drugs.

One new use for quicksilver is in the introduction of a small amount into the cylinders of steam turbines to improve the vapor pressure and thus increase efficiency. This mercury is recoverable and can be re-used, so that there is only a small proportional loss.

Quicksilver is an absolutely essential element from a military standpoint, as there has not yet been produced an entirely satisfactory commercial substitute for it in the manufacture of fulminating caps for explosives. However, in order to reduce consumption of the fulminate, some potassium chlorate, picric acid, trinitro-tuluol, or tetranitro-methalmine is sometimes mixed with it. The Ordnance Department of the U. S. Army, however, will accept no substitutes, as they have thus far proven unreliable.

Concentration of Quicksilver Ores.

For the above reason, and the fact that California has been, and still is, producing from 70% to 80% of the quicksilver yield of the United

[1]U. S. Tariff Comm., 2d Ann. Report, 1917-1918, p. 78, 1919.

States, an investigation of the possibilities of concentration for quicksilver ores, was undertaken by the State Mining Bureau. In the Bureau's investigation a wide variety of ores was tested by water concentration, flotation with oils, and a wet method by solution with an alkaline sulphide. Full details of this work, as well as furnace practices and descriptions of the California mines are given in Bulletin 78, issued during 1918.

New Equipment.

The most notable of recent developments in the metallurgy of quicksilver is the adaptation of the rotary cement-kiln to the reduction of quicksilver ore at the New Idria mine, San Benito County. They have there installed five such furnaces, with a combined daily capacity of 500 tons. The lead of the New Idria Company in the matter of rotary furnaces was followed at the Sulphur Bank mine, Lake County; Bella Union or Rutherford mine, Napa County; Cloverdale mine, Sonoma County, and at the January mine, Yolo County. The Cloverdale is the only one of these mines at present (July, 1920) operating.

Production.

Though some domestic yield of this metal is now obtained from Texas, Nevada, Arizona, and Oregon, the bulk of the output still comes from California.

The distribution of the 1919 product, by counties, was:

County	Flasks	Value
Lake	229	$20,604
Napa	644	58,140
San Benito	7,409	668,989
Santa Clara	3,012	271,762
Sonoma	1,418	119,142
Kern, Kings, San Luis Obispo, Siskiyou, Solano, Trinity, Yolo*	2,488	214,744
Totals	15,200	$1,353,381

*Combined to conceal output of a single operator in each.

The outlook for 1920 promises a still lower yield of quicksilver. The New Idria mine in San Benito County, for some years the largest producer in the western hemisphere, is at present (July, 1920) shut down as the result of a fire which destroyed the tramway terminal, ore-bins, and electrical equipment necessary for the operation of their rotary kilns. They are rebuilding, and expect to have one furnace running on ore by September 1, and to add another each 30 days thereafter until all five are doing duty. Neither the New Almaden property nor the Guadalupe in Santa Clara County are producing, nor the Oat Hill mine in Napa County.

Total Quicksilver Production of California.

Total amount and value of the quicksilver production of California, as given in available records, is shown in the following tabulation. Though the New Almaden mine in Santa Clara County was first worked in 1824, and has been in practically continuous operation since 1846 (though the yield was small the first two years), there are no available data on the output earlier than 1850. Previous to June, 1904, a 'flask' of quicksilver contained 76½ pounds, but since that date 75 pounds. In compiling this table the following sources of information were used: for 1850–1883, table by J. B. Randol, in Report of State Mineralogist, IV, p. 336; 1883–1893, U. S. Geological Survey reports; 1894 to date, statistical bulletins of the State Mining Bureau; also State Mining Bureau, Bulletin 27, "Quicksilver Resources of California," 1908, p. 10:

Year	Flasks	Value	Average price per flask	Year	Flasks	Value	Average price per flask
1850	7,723	$768,052	$99 45	1886	29,981	$1,064,326	$35 50
1851	27,779	1,859,248	66 93	1887	33,760	1,430,749	42 38
1852	20,000	1,166,600	58 33	1888	33,250	1,413,125	42 50
1853	22,284	1,235,648	55 45	1889	26,464	1,190,880	45 00
1854	30,004	1,663,722	55 45	1890	22,926	1,203,615	52 50
1855	33,000	1,767,150	53 55	1891	22,904	1,036,406	45 25
1856	30,000	1,549,500	51 65	1892	27,993	1,139,595	40 71
1857	28,204	1,374,381	48 73	1893	30,164	1,108,527	36 75
1858	31,000	1,482,730	47 83	1894	30,416	934,000	30 70
1859	13,000	820,690	63 13	1895	36,104	1,337,131	37 04
1860	10,000	535,500	53 55	1896	30,765	1,075,449	34 96
1861	35,000	1,471,750	42 05	1897	26,691	993,445	37 28
1862	42,000	1,526,700	36 35	1898	31,092	1,188,626	38 23
1863	40,531	1,705,544	42 08	1899	29,454	1,405,045	47 70
1864	47,489	2,179,745	45 90	1900	26,317	1,182,786	44 94
1865	53,000	2,432,700	45 90	1901	26,720	1,285,014	48 46
1866	46,550	2,473,202	53 13	1902	29,552	1,276,524	43 20
1867	47,000	2,157,300	45 90	1903	32,094	1,335,954	42 25
1868	47,728	2,190,715	45 90	1904	*28,876	1,086,323	37 62
1869	33,811	1,551,925	45 90	1905	24,655	886,081	35 94
1870	30,077	1,725,818	57 38	1906	19,516	712,334	36 50
1871	31,686	1,999,387	63 10	1907	17,379	663,178	38 16
1872	31,621	2,084,773	65 93	1908	18,039	763,520	42 33
1873	27,642	2,220,482	80 33	1909	16,217	773,788	47 71
1874	27,756	2,919,376	105 18	1910	17,665	799,002	45 23
1875	50,250	4,228,538	84 15	1911	19,109	879,205	46 01
1876	75,074	3,303,256	44 00	1912	20,600	866,024	42 04
1877	79,396	2,961,471	37 30	1913	15,661	630,042	40 23
1878	63,880	2,101,652	32 90	1914	11,373	557,846	49 05
1879	73,684	2,194,674	29 85	1915	14,199	1,157,449	81 52
1880	59,926	1,857,706	31 00	1916	21,427	2,003,425	93 50
1881	60,851	1,815,185	29 83	1917	24,382	2,396,466	98 29
1882	52,732	1,488,624	28 23	1918	22,621	2,579,472	114 03
1883	46,725	1,343,344	28 75	1919	15,200	1,353,381	89 04
1884	31,913	973,347	30 50				
1885	32,073	986,245	30 75	Totals	2,175,549	$105,925,413	

*Flasks of 75 lbs. since June, 1904; of 76½ lbs. previously.

SILVER.

Bibliography: State Mineralogist Reports IV, VIII, XII, XIII, XIV, XV. Bulletin 67. Min. & Sci. Press, March 1, 1919.

Silver in California is produced largely as a by-product from its association with copper, lead, zinc, and gold ores. As explained under the heading of Gold, the State Mining Bureau does not collect the statistics of silver production independently of the U. S. Geological Survey.

The average price of silver during 1919 was $1.12 per ounce at New York as compared with 54.8¢ in 1914; 50.7¢ in 1915; 65.8¢ in 1916; 82.4¢ in 1917; and $1 in 1918.

Because of delays incident to gathering data also for the Fourteenth Census, the final figures of the U. S. Geological Survey on the silver output are not yet available. For this reason, and in order not to further delay the publication of the data relating to the other minerals covered by the present bulletin, we have estimated the 1919 yield as segregated in the tabulation herewith.

[1]"The output of silver from California mines in 1919 is estimated at 1,121,069 fine ounces, valued at $1,244,386 which is 306,642 ounces less in quantity and $193,325 less in value than in 1918. The silver produced in California is derived mainly from copper and lead ores, although some is obtained with the gold mines at placers and in deep gold mines. The principal producers of silver in California are the Mammoth Mountain, Balakala, Shasta King, Afterthought, and Bully Hill copper mines in Shasta; the Engels Copper Co., in Plumas County; the Penn Copper Co., in Calaveras County; the Blue Ledge, in Siskiyou County; the Island, in Trinity County; and the Ivanpah, in San Bernardino County. These are all copper mines. The lead mines that produce silver in large quantity are the Darwin, Santa Rosa, Cerro Gordo, Tecopa, and Slate Range mines in Inyo County. These mines together produced 1,007,335 ounces of silver in 1918 and only 345,272 ounces in 1919, so the decrease from these combined properties was 662,063 ounces of silver. The output of a new productive silver mine in 1919, that of Rand Divide Mining Co., in Kern County, served to overcome to some extent the large deficiency shown by the mines mentioned above; but, this output though comparatively large, was not sufficient to make up entirely for the loss mentioned. Of the copper and lead mines named above, some were closed entirely in 1919, and the smelters in others were shut down for the year in April and May. All were much less productive in 1919 than in 1918. Notwithstanding the high prices of silver during the year, comparatively few of the old and long-idle silver and lead mines in the southern part of the State became very productive, though a number have been and are being reopened."

The distribution of the 1919 silver yield, by counties, is estimated as follows:

County	Value	County	Value
Amador	$20,000	Plumas	$155,000
Butte	2,500	Riverside	1,500
Calaveras	84,500	Sacramento	5,000
Del Norte	4	San Bernardino	40,000
El Dorado	700	Shasta	155,000
Fresno	40	Sierra	2,200
Humboldt	50	Siskiyou	16,000
Imperial	1,200	Trinity	7,500
Inyo	156,000	Tuolumne	17,000
Kern	457,000	Yuba	15,000
Madera	4,200	Modoc, San Joaquin, San Diego, Stanislaus*	1,070
Mariposa	5,500		
Mono	22,500		
Nevada	54,000	Total	$1,244,464
Placer	21,000		

*Combined to conceal output of a single operator in each.

[1]Yale, C. G., Press Bulletin, U. S. G. S., January, 1920.

The value of the silver produced in California each year since 1880 has been as follows, the data previous to 1887 being taken from the reports of the Director of the Mint:

Year	Value	Year	Value
1880	$1,140,556	1901	[2]$571,849
1881	750,000	1902	616,412
1882	845,000	1903	517,444
1883	1,460,000	1904	873,525
1884	[1]4,185,101	1905	678,494
1885	2,568,036	1906	817,830
1886	1,610,626	1907	751,646
1887	1,632,004	1908	878,057
1888	1,700,000	1909	1,091,092
1889	1,065,281	1910	993,646
1890	1,060,613	1911	673,336
1891	953,157	1912	799,584
1892	463,602	1913	832,553
1893	537,158	1914	813,938
1894	297,332	1915	851,129
1895	559,790	1916	1,687,345
1896	422,464	1917	1,462,955
1897	452,789	1918	1,427,861
1898	414,055	1919	1,244,464
1899	504,012		
1900	[2]724,500	Total	$40,964,236

[1]Lawver, A. M., in Production of Precious Metals in United States: Report of Director of Mint, 1884, p. 175; 1885.

[2]Recalculated to 'commercial' from 'coining value,' as originally published.

TIN.

Bibliography: Report XV. Bulletin 67.

Tin is not at present produced in California; but during 1891-1892, there was some output from a small deposit near Corona, in Riverside County, as tabulated below. Small quantities of stream tin have been found in some of the placer workings in northern California, but never in paying amounts.

Two occurrences have also been noted, in northern San Diego County. Crystals of cassiterite were found there, associated with blue tourmaline crystals, amblygonite and beryl. No commercial quantity has been developed, only small pockets having been taken out, as yet.

The principal source of the world's supply of tin is the Straits Settlements on the Malay Peninsula, followed in second rank by Bolivia. Siam, Burma and Cornwall are also important sources. A measurable amount of the metal is also recovered by de-tinning scrap and old cans.

Total output of tin in California:

Year	Pounds	Value
1891	125,289	$27,564
1892	126,000	32,400
Totals	251,289	$59,964

TUNGSTEN.

Bibliography: Report on San Bernardino County, 1917; Report XV. Bulletins 38, 67. U. S. G. S., Bull. 652. Proc. Colo. Sci. Soc., Vol. XI. South Dakota School of Mines, Bulletin No. 12.

The metal, tungsten, is used mainly in the steel industry and in the manufacture of electrical appliances, including the well-known tungsten filament lamps. Because of its resistance to corrosion by acids, it is valuable in making certain forms of chemical apparatus. Its employment in tool-steel alloys, permits the operation of cutting tools, such as in lathe work, at a speed and temperature at which carbon steel would lose its temper—hence the name 'high-speed' steels for these tungsten alloys. As made in the United States, tungsten forms 13% to 20% of such steels. Some chromium, nickel, cobalt, or vanadium, are sometimes also included.

Tungsten is introduced into the molten steel charge, either as the powdered metal or as ferro-tungsten (containing 50%-85% tungsten). The specific gravity of the pure metal, 19.3-21.4, is exceeded only by platinum, 21.5; iridium, 22.4; and osmium, 22.5. Its melting point is 3,267° C. (5,913° F.), being higher than any other known metal. Though millions of tungsten filament lamps are now made, the wires are so fine that the metal they contain represents but a few tons of tungsten concentrates annually.

Tungsten ore is produced in California principally in the Atolia-Randsburg district in San Bernardino and Kern counties, followed by the Bishop district in Inyo County, with small amounts coming from Nevada County and from the district near Goffs, in eastern San Bernardino. Most of the California tungsten ore is scheelite (calcium tungstate), though wolframite (iron-manganese tungstate) and hübnerite (manganese tungstate) also occur. The deposits at Atolia are the largest and most productive scheelite deposits known,[1] and the output has in some years equalled or exceeded that of ferberite (iron tungstate) from Boulder County, Colorado. It is interesting in this connection to note that, in practically all other tungsten producing districts of the world, wolframite is the important constituent. Burma, the largest producer, reported a yield of approximately 3,300 tons[2] of wolframite concentrates for 1917, most of which was obtained from placers, in part associated with cassiterite (tin oxide).

Imports of foreign tungsten ores into the United States during 1919 amounted to 8400 long tons valued at $6,261,190, compared with 10,362 long tons valued at $11,409,237 in 1918, which ores are duty free. Owing to lack of protection against the cheap coolie labor of Asiatic

[1]U. S. G. S., Bull. 652, p. 32.
[2]U. S. Commerce Reports, No. 167, July 18, 1918.

tungsten mines, and the present low market prices, practically all of the tungsten mines in the United States are now closed down.

The value of the ore is based upon the content of tungstic trioxide (WO_3), and quotations are commonly made per unit (each 1%) of WO_3 present.

In California in 1919, there were marketed 1214 tons of high-grade ore and concentrates, valued at $219,316, which is only about one-ninth of the quantity, and less than ten per cent of the value of the 1918 yield. The market prices quoted during 1919 ranged between $7 and $15. The tonnages here shown are recalculated to a basis of 60% WO_3. Most of the concentrates carried 59% to 63%. Previous to 1915, a single company produced almost all of California's tungsten. During the latter part of 1915, and the early months of 1916, because of the high prices prevailing, prospecting was much stimulated, and the known tungsten-bearing areas have been considerably extended both in San Bernardino and Kern counties. Some shipments were made from mines opened up in the Clark Mountain and New York Mountains districts in eastern San Bernardino County. In these latter areas, wolframite and hübnerite are the principal ores, with some scheelite, while at Atolia it is scheelite only. Scheelite ore is also extracted in Inyo County near Bishop, and three concentrating mills have been in operation there. The Nevada County ore is also scheelite.

There was no tungsten production in 1919 from either Kern or Nevada County; and the figures of Inyo County are combined with those of San Bernardino to conceal the output of a single producer in the last-named.

The annual value of tungsten produced in California since the inception of the industry is given herewith:

Year	Tons at 60% WO3	Value	Year	Tons at 60% WO3	Value
1905		$18,800	1914		$180,575
1906		189,100	1915	962	1,005,467
1907		120,587	1916	2,270	4,571,521
1908		37,750	1917	2,466	3,079,013
1909		190,500	1918	1,982	2,832,222
1910		208,245	1919	214	219,316
1911		127,706			
1912		206,000	Total		$13,221,475
1913		234,673			

VANADIUM.

Bibliography: Report XV. Bulletin 67. Proc. Colo. Sci. Soc., Vol. XI. U. S. Bur. of Mines, Bulletin 104.

No commercial production of vanadium has as yet been made in California. Occurrences of this metal have been found at Camp Signal, near

Goffs, in San Bernardino County, and two companies have done considerable development work in the endeavor to open up paying quantities. Each had a mill under construction in 1916, but apparently no commercial output was made. Ore carrying the mineral cuprodescloizite and reported as assaying 4% V_2O_5 was opened up. Late in 1917, some ore carrying lead vanadate was discovered in the 29 Palms, or Washington district, on the line between Riverside and San Bernardino counties. Vanadium has also been reported near Lotus in El Dorado County. There is a growing demand for vanadium, for use in the steel industry.

Quotations on the basis of vanadic acid are misleading. During 1918 prices ranged around $4 to $5 per pound of vanadium contained in ferro-vanadium. The cost of recovery is high. The association of copper is very detrimental.

ZINC.

Bibliography: Reports XIV, XV. Bulletins 38, 67.

During 1919, zinc was produced in Shasta, Inyo and San Bernardino counties to the amount of 1,334,192 pounds, valued at $101,046. This is less than one-fourth that of 1918 both in tonnage and value, due to the lower prices prevailing. The average price for the year was 7.3¢ per pound as compared to 5.1¢ during 1914; 14.2¢ in 1915; 13.4¢ in 1916; 10.2¢ in 1917, and 9.1¢ in 1918, showing a steady decline from the high-level prices of 1915.

The zinc ores of Shasta County are associated with copper, while those of Inyo and San Bernardino are associated principally with lead-silver ores. The ores were mainly shipped to Eastern smelters for treatment. The electrolytic zinc plant of the Mammoth Copper Company at Kennett with a capacity of 100 tons of spelter per month was in operation during 1918, but has since closed down. It treated bag-house fume. The Mammoth did not ship nor treat any raw zinc ores during 1918 or 1919. An electrolytic plant has been built at Bully Hill copper mine, Shasta County, also one at the Afterthought mine. Both of these are designed to treat raw ores direct, but no production of metal was made by them during 1919.

The production, by counties, was as follows:

County	Value	Pounds
Inyo	1,192,353	$87,042
Calaveras and Shasta*	191,839	14,004
Totals	1,384,192	$101,046

*Combined to conceal output of a single producer in each.

Total figures for zinc output of the state are as follows, commercial production dating back only to 1906:

Year	Pounds	Value	Year	Pounds	Value
1906	206,000	$12,566	1914	399,641	$20,381
1907	177,759	10,598	1915	13,043,411	1,617,383
1908	54,000	3,544	1916	15,950,565	2,137,375
1909			1917	11,854,804	1,209,190
1910			1918	5,565,561	506,466
1911	2,679,842	152,751	1919	1,384,192	101,046
1912	4,331,391	298,866			
1913	1,157,947	64,845	Totals	56,805,113	$6,135,011

CHAPTER FOUR.

STRUCTURAL MATERIALS

As indicated by this chapter heading, the mineral substances herein considered are those more or less directly used in building and structural work. California is independent, so far as these are concerned, and almost any reasonable construction can be made with materials produced in the state. This branch of the mineral industry for 1919 was valued at $16,796,754, as compared with a total value of $18,851,077 for the year 1918, the decrease being due to the drop in output of chromite and magnesite. Deposits of granite, marble and other building stones are distributed widely throughout this state, and slowly but surely transportation and other facilities are being extended so that the growing demand may be met. The largest single item, cement, has had an interesting record of growth since the inception of the industry in California about 1891. Not until 1904 did the annual value of cement produced reach the million-dollar mark, following which it increased 500% in nine years; though since 1913 it has fallen slightly below its high-level mark.

Crushed rock production is yearly becoming more worthy of consideration, due to the strides recently taken in the use of concrete, as well as to activity in the building of good roads. Brick, with an annual output worth approximately $2,000,000, has slowly decreased, due to the popularity of cement and concrete; nevertheless, this item will be an important one for many years to come, and of course, a market for fire and fancy brick of all kinds will never be lacking.

Fifty-four counties contributed to this structural total for 1919, and there is not a county in the state which is not capable of some output of at least one of the materials under this classification.

The following table gives the comparative figures for the amounts and value of structural materials produced in California during the years 1918 and 1919:

Substance	1918		1919		Decrease— Increase+ Value
	Amount	Value	Amount	Value	
Bituminous rock	2,561 tons	$9,067	4,614 tons	$18,537	$9,470+
Brick and tile		2,363,481		3,087,067	723,586+
Cement	4,772,921 bbls.	7,969,909	4,645,289 bbls.	8,591,990	622,081+
Chromite	73,955 tons	3,649,497	[1]4,314 tons	97,164	3,552,333—
Granite		139,861		220,743	80,882+
Lime	436,843 bbls.	461,315	420,696 bbls.	552,042	90,728+
Magnesite	83,974 tons	803,492	44,696 tons	452,094	351,398—
Marble	17,428 cu. ft.	49,898	25,020 cu. ft.	74,482	24,584+
Sandstone	900 cu. ft.	400	5,400 cu. ft.	3,690	3,290+
Miscellaneous stone		3,404,157		3,698,944	294,787+
Total value		$18,851,077		$16,796,754	
Net decrease					$2,054,323—

[1]Recalculated to 45 per cent Cr_2O_3.

ASPHALT.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 16, 32.

Asphalt was for a number of years accounted for in reports by the State Mining Bureau, because in the early days of the oil industry, considerable asphalt was produced from outcroppings of oil sand, and was a separate industry from the production of oil itself. However, at the present time most of the asphalt comes from the oil refineries, which produce a better and more uniform grade; hence, its value is not now included in the mineral total, as to do so would be a partial duplication of the crude petroleum figures. Such natural asphalt as is at present mined is in the form of bituminous sandstones, and is recorded under that designation.

According to the U. S. Geological Survey, the war stimulated activity in the domestic markets for asphaltic materials derived from crude petroleum and for imported asphalt, but relative abundance and adaptability of those materials has lessened the demand for the native bitumens and for the various types of bituminous rock produced in this country.

The production of refinery asphalt from 14 refineries in California has averaged between 200,000 tons and 250,000 tons, worth approximately $2,000,000, per year, for several years past. California leads all other states of the union in such production, as her crude oils are almost entirely of asphaltic base.

BITUMINOUS ROCK.

Bibliography: State Mineralogist Reports XII, XIII, XV.

The manufacture of asphalt at the oil refineries has almost eliminated the industry of mining bituminous rock, but small amounts of the latter are still used occasionally for road dressing. The production during 1919 from one quarry each in Santa Cruz, Santa Barbara and San Luis Obispo counties was 4,614 tons, valued at $18,537, compared with 2,561 tons and $9,067 in 1918.

The following tabulation shows the total amount and value of bituminous rock quarried and sold in California, from the records compiled by the State Mining Bureau, annually since 1887:

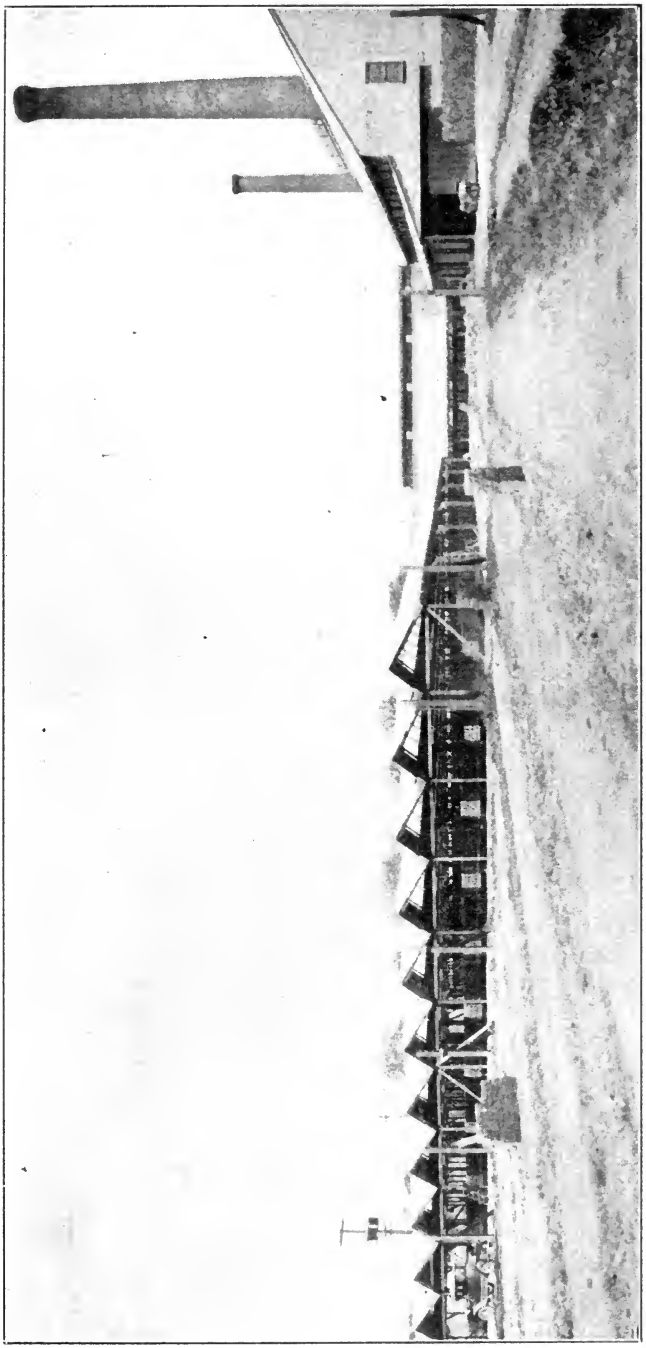
Year	Tons	Value	Year	Tons	Value
1887	36,000	$160,000	1905	24,753	$60,436
1888	50,000	257,000	1906	16,077	45,204
1889	40,000	170,000	1907	24,122	72,835
1890	40,000	170,000	1908	30,718	109,818
1891	39,962	154,164	1909	34,123	116,436
1892	24,000	72,000	1910	87,547	165,711
1893	32,000	192,036	1911	75,125	117,279
1894	31,214	115,193	1912	44,073	87,467
1895	38,921	121,586	1913	37,541	78,479
1896	49,456	122,500	1914	66,119	166,618
1897	45,470	128,173	1915	17,789	61,468
1898	46,836	137,575	1916	19,449	66,561
1899	40,321	116,097	1917	5,590	18,580
1900	25,306	71,495	1918	2,561	9,067
1901	24,052	66,354	1919	4,614	18,537
1902	33,490	43,411			
1903	21,944	53,106	Totals	1,154,453	$3,520,866
1904	45,280	175,680			

BRICK and TILE.

Bibliography: Reports XIV, XV. Bulletin 38. Preliminary Report, No. 7.

As would be expected in a state with diversified and widespread mineral resources, a great variety of brick is annually produced in California, including common, fire, pressed, glazed, sand-lime, and others. As far as possible the different kinds have been segregated in the following tabulation. We also include under this heading the various forms of hollow building 'tile' or blocks, instead of under industrial pottery clays as in the reports previous to 1915.

The clay industries throughout the country were adversely affected by the war-time restrictions on building operations, and particularly during 1918 by a 50% cut in their fuel and power allowances by the Federal Fuel Administrator. That they have already largely recovered from that condition, is shown by comparison of the 1919 figures with those of previous years.



Plant of Peterson-Kartschoke Brick Company, San José, Santa Clara County.

The detailed figures of brick and tile production for 1919, by counties, are given in the following tabulation:

Brick and Tile Production, by Counties, for 1919.

County	Common		Fire		Glazed, pressed, fancy, vitrified		Hollow building tile or blocks		Total value
	Amount, M	Value	Amount, M	Value	Amount, M	Value	Tons	Value	
Alameda	14,296	$152,670							$152,670
Contra Costa	10,738	119,349	353	$15,807					135,156
Kern	1,709	175,112							175,112
Los Angeles	60,368	677,812	5,203	192,737	5,443	$210,169	13,272	$104,436	1,185,154
Orange	1,000	12,989							12,989
Riverside			5,229	104,822					104,822
San Diego	4,000	44,000							44,000
Santa Clara	7,250	65,000							
Fresno, Humboldt, Imperial, Marin, Riverside, Sacramento, San Joaquin, Santa Barbara, Shasta, Tehama, Tulare, Ventura*	35,548	454,657							
Alameda, Amador, Placer, San Joaquin*			10,119	408,143					
Alameda, Contra Costa, Placer, Riverside, Sacramento*					5,072	156,207			
Alameda, Placer, Riverside, Sacramento, San Diego, Tulare*							22,754	193,157	1,212,164
Totals	124,909	$1,701,589	20,904	$721,509	10,515	$366,376	36,026	$297,593	$3,087,067

*Combined to conceal output of a single producer in each.

Record of brick production in the state has been kept since 1893 by this Bureau, the figures for building tile being also included since 1914. The annual and total figures, for amount and value, are given in the following table:

Year	Brick, M.	Building blocks, tons	Value
1893	103,900		$801,750
1894	81,675		457,125
1895	131,772		672,360
1896	24,000		524,740
1897	97,468		563,240
1898	100,102		571,362
1899	125,950		754,730
1900	137,191		905,210
1901	130,766		860,488
1902	169,851		1,306,215
1903	214,403		1,999,546
1904	281,750		1,994,740
1905	286,618		2,273,786
1906	277,762		2,538,848
1907	362,167		3,438,951
1908	332,872		2,506,495
1909	333,846		3,059,929
1910	340,883		2,934,731
1911	327,474		2,638,121
1912	337,233		2,940,290
1913	358,754		2,915,350
1914	270,791		2,288,227
1915	180,538		1,678,756
1916	206,960		2,096,570
1917	192,269	29,348	2,532,721
1918	136,374	34,818	2,363,481
1919	156,328	36,026	3,087,067
Totals	5,699,697	100,192	$50,704,829

CEMENT.

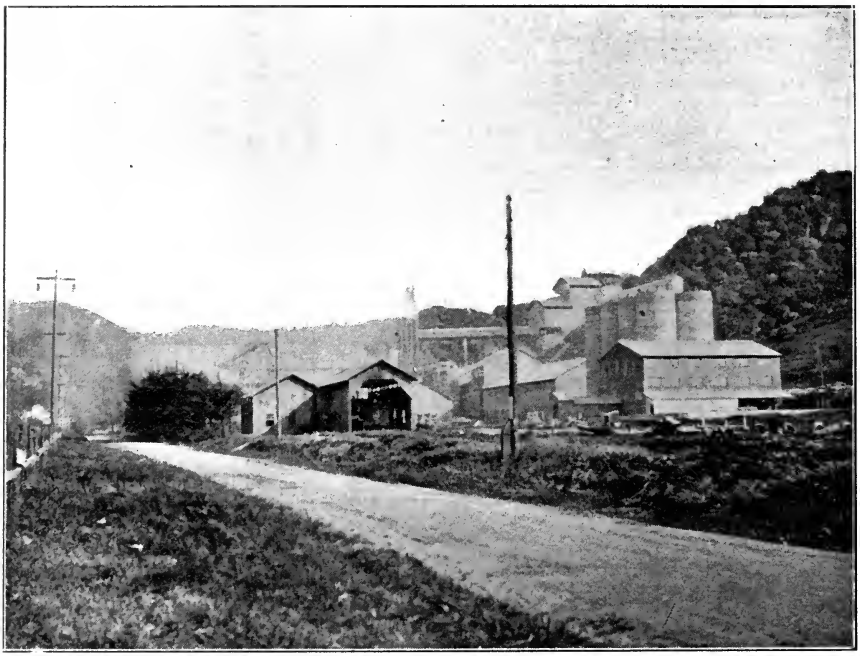
Bibliography: State Mineralogist Reports VIII, IX, XII, XIV, XV. Bulletin 38.

Cement is one of the most important structural materials in the output of the state. During 1919 there was produced a total of 4,645,289 barrels, valued at $8,591,990, being a slight decrease in quantity but an increase in value over the 1918 figures. This output comes from eight operating plants in six counties. The feature of the 1919 production is the increased average price per barrel.

Several of the cement plants recovered potash-bearing materials as by-products, notably: the Riverside Portland Cement Company, Riverside County; California Portland Cement Company and Southwestern

Portland Cement Company, San Bernardino County; Santa Cruz Portland Cement Company, Santa Cruz County. The first-named was the pioneer in this work.

The cement industry is so centralized that it is not possible to apportion the production to the counties in which plants are located without making private business public. With the exception of San Bernardino, no county has more than one cement plant. The three operating plants in San Bernardino County, in 1919, made a total of 1,078,943



Plant of the Old Mission Portland Cement Company, San Juan Bautista, San Benito County, which began operations in 1918.

barrels, valued at $1,717,998; the balance coming from a single plant in each of the following counties: Contra Costa, Riverside, San Benito, Santa Cruz and Solano.

'Portland' cement was first commercially produced in the state in 1891; though in 1860 and for several years following, a natural hydraulic cement from Benicia was utilized in building operations in San Francisco. While the total figures are not of the same magnitude as those for gold and petroleum, the growth of the industry has been more than rapid, and a comparison of the annual figures representing the output since the inception of the industry is of interest.

Annual production of cement in California has been as follows:

Year	Barrels	Value	Year	Barrels	Value
1891	5,000	$15,000	1907	1,613,563	$2,585,577
1892	5,000	15,000	1908	1,629,615	2,359,692
1893	----------	----------	1909	3,779,205	4,969,437
1894	8,000	21,600	1910	5,453,193	7,485,715
1895	16,383	32,556	1911	6,371,369	9,085,625
1896	9,500	28,250	1912	6,198,634	6,074,661
1897	18,000	66,000	1913	6,167,806	7,743,024
1898	50,000	150,000	1914	5,109,218	6,558,148
1899	60,000	180,000	1915	4,918,275	6,044,950
1900	52,000	121,000	1916	5,299,507	6,210,293
1901	71,860	159,842	1917	5,790,734	7,544,282
1902	171,000	423,600	1918	4,772,921	7,969,909
1903	640,868	968,727	1919	4,645,289	8,591,990
1904	969,538	1,539,807			
1905	1,265,553	1,791,916	Totals	66,377,971	$90,677,851
1906	1,286,000	1,941,250			

CHROMITE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV, XV. Bulletins 38, 76. Preliminary Report 3, U. S. G. S., Bull. 430. Min. & Sci. Press, Vol. 114, p. 552.

Chromic iron ore, or chromite, to the amount of 4,139 short tons of all grades (or 4,314 tons, re-calculated to a basis of 45% Cr_2O_3), valued at $97,164 f.o.b. shipping point was sold in California during the year 1919. At least 500 tons of this was mined in 1918, but not shipped that year. There are still on the ground, mined but not sold, various lots of ore throughout the chrome districts of the state, aggregating several thousand tons, which have not been shipped, owing to the radical drop in price and demand, following the close of the war late in 1918. The above amount sold in 1919 is but a fraction of the 73,955 tons of all grades valued at $3,649,497 shipped in 1918. There were 24 shippers or producers in 1919 as compared with 236 in 1918 who shipped, individually, amounts varying from a few tons to 6,000 tons.

Chromite is widely distributed in California, the principal production, thus far, having come from El Dorado, San Luis Obispo, Del Norte, Shasta, Siskiyou, Placer, Fresno, and Tuolumne counties. In 1918 a total of 29 counties contributed to the state's output.

Economic Conditions.

Chromite is one of several of California's minerals most affected by the economic conditions brought about by the European war. The major portion of our domestic requirements for chrome is for consumption in the steel mills of the East. Formerly, most of that used

was imported from Rhodesia and New Caledonia, and they are still the more important sources. The reports of the U. S. Department of Commerce show the foreign imports of chromic iron for the six years 1913-1919 (inc.) to have been 49,772; 75,455; 115,886; 72,063; 100,142 and 61,404 long tons, respectively. The average price of imports in 1919 was $22.49 per ton, and a total of 71% of the tonnage was furnished by Cuba, Australia, Canada, and French Oceania, in the order named. Similarly to conditions discussed herein under manganese (see *ante*), the increased demand for steel products also increased the necessity for chromite as a refractory and for the preparation of ferro-chrome. Our own domestic sources supplied a part of the increased demand.

According to Dolbear,[1]

"to be readily salable chrome ore should contain at least 40% chromic oxide (Cr_2O_3) and less than 8% silica (SiO_2). Some ore is sold which carries not more than 30% Cr_2O_3; sometimes SiO_2 as high as 10% to 15% is permitted. Ore containing 40% Cr_2O_3 is more satisfactory in fire brick manufacture than 30% or 50% ore. When other grades are purchased they are sometimes crushed and mixed with higher or lower grades, as may be required, to secure a 40% product."

The major consumption of chromic ore is for its use as a refractory lining in smelting furnaces for steel and copper. A smaller portion is used in the preparation of ferro-chrome for chrome-steel alloys. Some of the California product in 1916-1918 was converted into ferro-chrome in the electric furnaces of the Noble Electric Steel Company at Heroult, Cal., and some of it was similarly reduced in electric furnaces at Niagara Falls, N. Y. A small amount of high-grade ore was utilized in preparation of chromates for tanning.

A report, designated as Bulletin No. 76, of the State Mining Bureau, was issued in 1918, giving a detailed account of California's resources in both manganese and chromite.

The War Mineral Relief Commission is still working on the adjustment of claims for chromite mined in 1917-1918, but the law as at present worded is too restricted. An amendment to the Dent Bill (H. R. 13274) has been introduced in Congress to permit of a more liberal interpretation in the consideration of claims.

Occurrence.

Until 1916, when some shipments were made from Oregon and smaller amounts from Maryland, Wyoming and Washington, practically our only domestic production of chromite for many years came from California. From 1820 to 1860 the deposits in Pennsylvania and Maryland supplied the world's consumption. There are two main belts in California yielding this mineral,—one, along the Coast Ranges from San Luis Obispo County to the Oregon line, including Klamath Mountains

[1]Dolbear, S. H., Min. and Sci. Press, April 21, 1917, p. 554.

at the north end, and the other in the Sierra Nevada from Tulare County to Plumas County. Chromite occurs as lenses in basic igneous rocks such as peridotite and pyroxenite, and in serpentines which have been derived by alteration of such basic rocks. For the most part, so far as developments have yet shown, the lenses have proven to be small, relatively few of them yielding over 100 tons apiece. A notable exception to this was the deposit on Little Castle Creek near Dunsmuir, from which upwards of 15,000 tons were shipped before it was exhausted. Deposits worked in Del Norte County during 1918 promised well for a large tonnage. On the whole the orebodies in the northwestern corner of the state appear to average larger in size than the chromite lenses in other parts of California.

Concentration became an accomplished fact in several localities, thus utilizing some of the disseminated and lower-grade orebodies which have been found. In fact, an important part of the 1918 production came from this source.

Prices and Production.

During 1919 the prices in California on the basis of 45% chromic oxide ranged from $15 to $35 per ton f. o. b., with a premium for higher grades and deductions for lower. The producers' reports to the State Mining Bureau indicate an average of approximately $23.50 per ton received for all grades for the year as against $49.35 in 1918, $21.60 in 1917, and $14.65 in 1916. For the eastern buyer, to these prices freight charges of $11 to $16 per ton, had to be added. For the present year (1920), some ore is moving, and in April was selling at 20¢ per unit, f. o. b. California points for lump ore, containing 45% to 48% chromic oxide, and 40¢ to 50¢ per unit for concentrates containing 48% to 50% Cr_2O_3.

The distribution of the 1919 product, by counties, was as follows, the tonnage being recalculated to 45% Cr_2O_3:

County	Tons	Value
Alameda	80	$1,264
E' Dorado	378	6,510
Placer	1,018	24,000
San Luis Obispo	1,158	26,431
Siskiyou	510	13,379
Fresno, Glenn, Mendocino, Nevada, Santa Barbara, Tulare, Tuolumne*	1,170	25,580
Totals	4,314	$97,164

*Combined to conceal output of a single operator in each.

Total Chromite Production of California.

Production of chromite in California began, apparently, about 1874, principally in San Luis Obispo County. There was considerable activity from 1880 to 1883, inclusive, and a total of 23,238 long tons (or 26,028 short tons), valued at $329,924 was shipped from that county up to the beginning of 1887. Some ore also was shipped from the Tyson properties in Del Norte County. The tabulation herewith shows the output of chromite in California, annually, including the earliest figures so far as they are available. The figures from 1887 to date are from the records of the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1874–1886 (San Luis Obispo Co.)	26,028	$329,924	1904	123	$1,845
1887	3,000	40,000	1905	40	600
1888	1,500	20,000	1906	317	2,859
1889	2,000	30,000	1907	302	6,040
1890	3,599	53,985	1908	350	6,195
1891	1,372	20,580	1909	436	5,309
1892	1,500	22,500	1910	749	9,707
1893	3,319	49,785	1911	935	14,197
1894	3,680	39,980	1912	1,270	11,260
1895	1,740	16,795	1913	1,180	12,700
1896	786	7,775	1914	1,517	9,434
1897			1915	3,725	38,044
1898			1916	48,943	717,244
1899			1917	52,379	1,130,298
1900	140	1,400	1918	73,955	3,649,497
1901	130	1,950	1919	*4,314	97,164
1902	315	4,725	Totals	239,794	$6,354,592
1903	150	$2,250			

*Recalculated to 45 per cent Cr_2O_3.

GRANITE.

Bibliography: State Mineralogist Reports X, XII, XIII, XIV, XV. Bulletin 38.

In the reports for several years previous to 1916 granite was treated as a subdivision under 'Stone Industry' or under 'Miscellaneous Stone.' We have since rearranged the subjects, somewhat, and now give granite a separate heading, as had previously been done with marble and sandstone. Crushed rock and paving blocks derived from granite quarries are continued under the heading of 'Miscellaneous Stone.'

The output of granite, particularly for building and ornamental purposes, shows a falling off since 1914 from earlier annual amounts. That granite is not used more is probably due to its greater cost as compared to concrete and ornamental brick and tile for buildings. Since 1915 there have been no new large pieces of work undertaken.

Building operations of all kinds, except those directly connected with war contracts, were largely suspended.

California building granites, particularly the varieties from Raymond, Madera County, and Rocklin, Placer County, are unexcelled by any similar stone found elsewhere.

Granites of excellent quality for building and monumental purposes are also quarried in Riverside and San Diego counties. The Fresno County stone is a dark, hornblende diorite, locally called 'black granite,' whose color permits of a fine contrast of polished and unpolished surfaces, making it particularly suitable for monumental and decorative purposes. There is also a similar 'black granite' in Tulare County.

In so far as it has been possible to do so, granite production has been segregated in the following table into the various uses to which the product was put. It will be noted, however, that a portion of the output has been entered under the heading 'unclassified.' This is necessary because of the fact that some of the producers have no way of telling to what specific use their stone was put after they had quarried and sold the same.

Granite Production, by Counties, for 1919.

County	Building stone		Monumental		Curbing		Unclassified		Total value
	Cubic feet	Value	Cubic feet	Value	Linear feet	Value	Cubic feet	Value	
Fresno			15,000	$34,500					$34,500
Madera	13,312	$14,062	28,454	49,796	390	$500			64,358
Placer	3,703	11,282	5,260	19,149	5,318	5,697	49	$105	36,233
Riverside	[1]14,229	10,536	3,859	5,735	1,250	674	700	1,080	17,975
San Diego	200	350	6,490	14,865					15,215
Sonoma	[2]162	16			[2]210	21	[3]100	25	62
Nevada, Tulare and Tuolumne*	2,000	6,000	11,000	45,500			1,200	900	52,400
Totals	33,606	$42,246	70,063	$169,545	7,168	$6,892	2,049	$2,060	$220,743

[1]Includes some monumental stone.
[2]Trachytic tuff.
[3]Basalt.
*Combined to conceal output of a single operator in each.

The value of granite produced, annually since 1887, has been as follows:

Year	Value	Year	Value
1887	$150,000	1905	$353,837
1888	57,000	1906	344,083
1889	1,329,018	1907	373,376
1890	1,200,000	1908	512,923
1891	1,300,000	1909	376,834
1892	1,000,000	1910	417,898
1893	531,322	1911	355,742
1894	228,816	1912	362,975
1895	224,329	1913	981,277
1896	201,004	1914	628,786
1897	188,024	1915	227,928
1898	147,732	1916	535,339
1899	141,070	1917	221,997
1900	295,772	1918	139,861
1901	519,285	1919	220,743
1902	255,239		
1903	678,670	Total	$14,968,352
1904	467,472		

LIME.

Bibliography: Reports XIV, XV. Bulletin 38.

Lime to the amount of 420,696 barrels, valued at $552,043, was produced by seven plants in five counties during 1919, as compared with 436,843 barrels, valued at $461,315 in 1918. As in 1918, the quantity decreased, but the value increased. So far as we have been able to segregate the data, this figure includes only such lime as is used in building operations. That utilized in sugar making, for smelter flux, and as a fertilizer are classified under 'Industrial Materials.' That consumed in cement manufacture is included in the value of cement.

Distribution by counties is shown in the following table:

County	Barrels	Value
Kern	86,952	$112,724
Santa Cruz	150,271	234,039
San Bernardino, Shasta, Tuolumne*	183,473	205,280
Totals	420,696	$552,043

*Combined to conceal output of a single operator in each.
For table of production by years, see under 'Industrial' limestone, *post*.

MAGNESITE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38. U. S. G. S., Bulletins 355, 540. Min. & Sci. Press, Vol. 114, p. 237. "Magnesite"—Hearings before the Comm. on Ways and Means, House of Repr. on H. R. 5218, June 16, 17 and July 17, 1919.

Occurrence.

Magnesite is a natural carbonate of magnesium, and when pure contains 52.4% CO_2 (carbon dioxide) and 47.6% MgO (magnesia). It has a hardness of 3.5 to 4.5, and specific gravity of 3 to 3.12. It is both harder and heavier than calcite (calcium carbonate), and also contains a higher percentage of CO_2, as calcite has but 44%.

Most of the California magnesite is comparatively pure, and is ordinarily a beautiful, white, fine-grained rock with a conchoidal fracture resembling a break in porcelain. The Grecian magnesite is largely of this character; while the Austrian varieties usually contain iron so that they become brown after calcining. The Washington magnesite, one of the most recent developments, resembles dolomite and some crystalline limestones in physical appearance. Its color varies through light to dark gray, and pink.

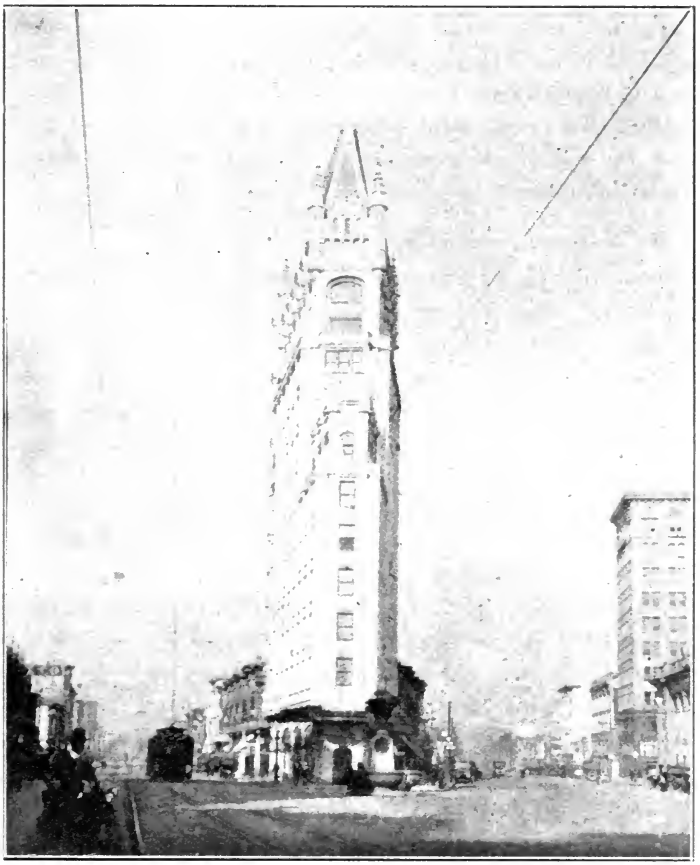
In California, the known deposits are mostly in the metamorphic rocks of the Coast Ranges and Sierra Nevada Mountains, being associated with serpentine areas. The notable exceptions are two sedimentary deposits, one at Bissell in Kern County, and one at Afton in San Bernardino County. Several thousand tons have been shipped from the Bissell deposit; and shipments have recently begun from the Afton property.

The Washington deposits are stated to be associated with extensive strata of dolomitic limestones. The magnesite there appears to contain more iron than most of the California mineral, which makes it desirable for the steel operators. However, the experience of the past four years has proven that several California localities have sufficient iron in their magnesite to be serviceable in the steel furnaces. This is particularly true of the Refractory Magnesite Company's mine near Preston in Sonoma County, and the White Rock Mine at Pope Valley, Napa County.

Uses.

The principal uses at the present time include: refractory linings for basic open-hearth steel furnaces, copper reverberatories and converters, bullion and other metallurgical furnaces; in the manufacture of paper from wood pulp; and in structural work, for flooring, wainscoting, tiling, sanitary kitchen and hospital finishing, etc. In connection with

building work, it has proven particularly efficient as a flooring for steel railroad coaches, on account of having greater elasticity and resilience than 'Portland' cement. For refractory purposes, the magnesite is 'dead burned'—*i. e.*, all or practically all of the CO_2 is expelled from it. For cement purposes, it is left 'caustic'—*i. e.*, from 5% to 10% of



Federal Realty Building, Oakland, California, finished with magnesite paint (a thin, Sorel cement).

CO_2 is retained. When dry caustic magnesite is mixed with a solution of magnesium chloride ($MgCl_2$) in proper proportions, a very strong cement is produced, known as oxychloride or Sorel cement. It is applied in a plastic form, which sets in a few hours as a tough, seamless surface.

It is stated that some metallic magnesium has been prepared electrolytically at Niagara Falls, from magnesite (see also Magnesium Chloride, under 'Salines,' *post*).

For refractory purposes, the calcined magnesite is largely made up into bricks, similar to fire-brick for furnace linings. It is also used un-consolidated, as 'grain' magnesite. For such, an iron content is desirable, as it allows of a slight sintering in forming the brick. Dead-burned, pure, magnesia cannot be sintered except at very high temperatures; and it has little or no plasticity, so that it is hard to handle. Its plasticity is said to be improved by using with it some partly calcined or caustic magnesite. Heavy pressure will bind the material sufficiently to allow it to be sintered.

A coating of crushed magnesite is laid on hearths used for heating steel stock for rolling, to prevent the scale formed from attacking the fire-brick of the hearth.

Imports, and Domestic Production.

Reports of the U. S. Bureau of Foreign and Domestic Commerce show imports of calcined magnesite to have been 172,591 tons in 1913; 144,747 tons in 1914; and 63,347 tons in 1915; most of it coming from Austria-Hungary. For the same years, the production of crude (about two tons of crude ore required to yield one ton of the calcined) magnesite in California (the sole producer for those years, in the United States) was: 9,632 tons, 1913; 11,438 tons, 1914; 30,721 tons, 1915. For 1916 the California output leaped to 154,052 tons of crude and to 209,648 tons in 1917, but dropped considerably in 1918 and 1919. Shipments were begun from Washington late in 1916.

A bill (H. R. 5218) has been introduced in Congress to provide for an import duty of ¾¢ per pound on crude magnesite, 1¼¢ per pound on calcined, and 25% *ad valorem* on magnesite brick. The House Committee on Ways and Means held a series of hearings on this bill, June 16, 17 and July 17, 1919, at which much valuable data relative to American magnesite was presented.[1] Final action on the bill has not yet been taken.

Previous to the war, Austrian magnesite was sold at Chester, Pa., and Baltimore, Md., at $16.15 per net ton. The rail rate from the mines to Triest is stated to have been $4 per ton, and the ocean rate, at times as low as $2 per ton, as it came over largely in ballast.

Sworn statements of cost were presented by various American operators at the above-mentioned hearings. Washington costs were shown to be from $21 to $25 per ton of calcined ready for shipment.

The following California costs of calcined ore, f.o.b. shipping point, were given: Porterville Magnesite Co., $28.43 per ton; Tulare Mining Co., $24.97; Western Magnesite Development Co., $24.16; White Rock

[1]Magnesite. Hearings before the Committee on Ways and Means, House of Representatives, on H. R. 5218, June 16 and 17, 1919; Part II, July 17, 1919. Gov't Printing Office, 1919.

Mine, $28.22. The average cost per ton for the six principal producers in Washington and California was $25.13 per ton. Add to this the transcontinental freight rate of $16.07, and we have a cost of $41.20 for American magnesite at Atlantic ports.

"CALCINING CAPACITY OF THE UNITED STATES.[1]

"The capacity of the calcining plants of California is estimated at 350 to 400 tons daily or 10,000 to 12,000 tons monthly. In Washington considering one plant alone, the Northwest Magnesite Co., there is a calcining capacity of 10,000 tons per month, making in all a capacity of 20,000 tons per month, or 240,000 tons per year, which is far more than ample for the needs of the United States.

"QUANTITY OF MAGNESITE USED PER TON OF STEEL.

"Prior to the war between 6 and 14 pounds of magnesite was used per ton of steel, according to estimates of several prominent eastern steel manufacturers. The quantity used was cut in half during the war owing to a greater measure of economy and the substitution for magnesite of dead-burned dolomite. About 3 to 7 pounds, or an average of 5 pounds per ton of steel, was used during 1917, which quantity may be considered approximately that now used. Thus, it will be seen that the quantity of magnesite now consumed per ton of steel is only 50 per cent of what it was prior to the war.

"The cost of magnesite per ton of steel is small and this spring with the price of magnesite brick at $450 per thousand and with grain magnesite at Chester, Pa., at $48.50 per ton, the cost of magnesite per ton of steel on the basis of all brick was about 22½ cents, and on the basis of grain magnesite 12½ cents. The cost of magnesite per ton of steel must lie somewhere between these limits and, assuming the use of half brick and half grain, would not be far from 17 to 18 cents, under the prices which prevailed this spring. On the basis of two-thirds brick and one-third grain the cost would be about 19 cents. These prices have been abnormally high and it is probable that 8 or 9 cents per ton of steel is nearer the truth for normal prewar conditions, but greater economy in the use of magnesite, and especially in the use of dead-burned grain and the substitution therefor of dead-burned dolomite have tended to offset the high war prices.

"Dead-burned dolomite has been used in the past as a refractory in repairing furnace linings, but statistics showing the extent of this application are lacking. According to data of the United States Geological Survey 340,000 tons of dead-burned dolomite was marketed in 1917—figures which indicate at least an important degree of competition with grain magnesite."

* * * * * * *

"FREIGHT RATES AND COSTS AT EASTERN POINTS.

"The recent price for Washington calcined magnesite has been $32.50 per ton at Chewelah, Wash. Little or no California magnesite has recently come East for refractory purposes, but some has been shipped to Chicago for plastic purposes. The latter involves very careful selection and fine grinding and is put in bags. Consequently, it is much higher in price than that used for refractory purposes, and the price varies with the care exercised in preparation. Magnesite brick this spring at Chester, Pa., were $90 per ton, or $450 per thousand, and this price is still quoted in some of the latest technical journals.

"Freight rates plus war tax to Pittsburg from California and Washington points are $14.21 per ton and to Chester, Pa., $16.07 per ton, making the total cost per ton of grain magnesite at these points $46.71 and $48.57, respectively. The freight rate on calcined Canadian magnesite to Pittsburg, Pa., is about $8.50 which is just about half of what it was from the western points to that city.

"LOCATION OF PRINCIPAL REFRACTORY COMPANIES.

"There are undoubtedly many small manufacturers of magnesite brick scattered over the country. The great bulk of the brick is, however, turned out by 9 to 10 concerns, and of these 4 or 5 companies produce most of the brick manufactured. These largest magnesite brick concerns are all in the eastern part of the United States, from the Mississippi Valley to Pennsylvania points. The plant of the Harbison-Walker Co., where magnesite brick is made, is at Chester, Pa.; that of the American Refractories Co. is at Baltimore, Md.; that of the General Refractories Co. is at Bolivar, Pa.; that of Federal Refractories Co. is at Lock Haven, Pa. Other plants are located at Johnstown, Pa., and St. Louis, Mo., Salt Lake City, Utah, and at Seattle and Spokane, Wash. Of course, grain magnesite for furnace use may be shipped direct to the consumers; it is only the material sold in the form of brick that has to go into the trade by way of brick-making establishments."

Some conflicts arose in the testimony as to the relative qualities of the American and foreign magnesite; but the more reliable data presented indicated that the American article is equal in quality to any other.

[1] *Op. cit.*, pp. 218, 219.

Output and Value.

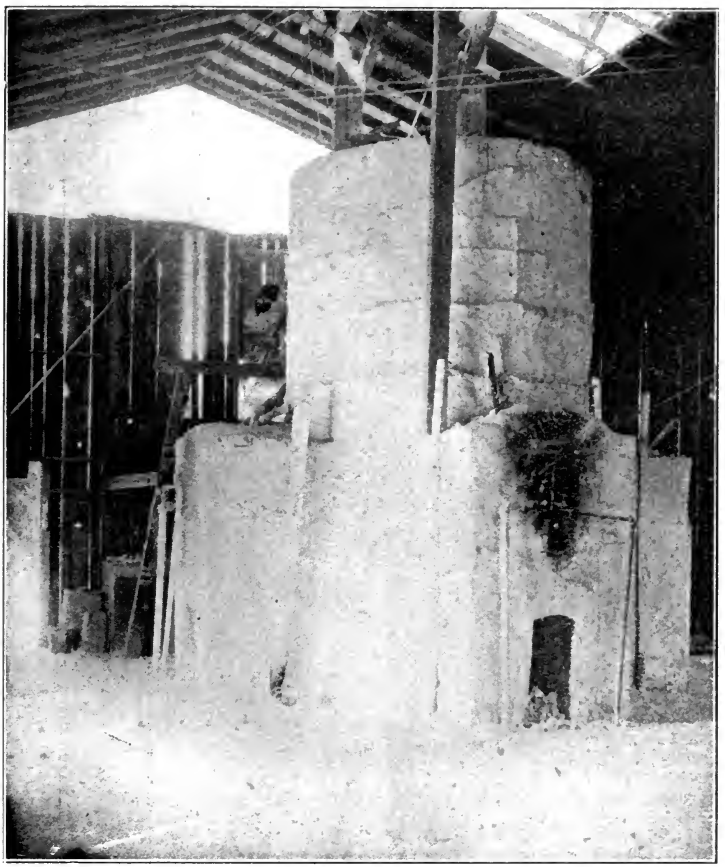
In considering mineral production the value of the crude material is used as far as practicable. Magnesite presents a peculiar example of a material which previous to 1916 was seldom handled on the market in the crude state. It is mainly calcined and ground before being considered marketable. From 2 to 2½ tons of the crude material are mined to make one ton of the calcined. In the earlier reports an arbitrary value for the crude material at the mine was calculated from the above on the basis of the calcined value, there having been very little product shipped crude. On the contrary, however, considerable tonnages since 1916 have been shipped in the crude state, contracted for at prices ranging from $7 to $14 per ton, f.o.b. rail points, or an average of about $10.10 per ton, for 1919. This is the basis of the valuation used herein.

The production of crude magnesite in California during the year 1919, totaled 44,696 tons valued at $452,094 f.o.b. rail-shipping point. This is considerably less than half the 1918 output of 83,974 tons and $803,492. This is due in large part, as indicated in preceding paragraphs, to the development of the deposits in the state of Washington, which are stated to have produced 97,720 tons in 1919.

Some magnesite has also been imported from eastern Canada, which is closer to the steel-producing centers. The Canadian magnesite, though containing an objectionable percentage of lime, is being used on account of being cheaper and nearer at hand. Importations from Austria were resumed to a limited extent in 1919.

It looks as if the main hope for the future for California magnesite lies in the development of the plastic business in the territory west of the Rocky Mountains; and in the manufacture of refractory brick to be utilized mainly by the copper and lead smelters in the same district. It is possible that, after ocean shipping has resumed its normal routes, California magnesite may be sent via the Panama Canal to the Atlantic seaboard; but, on account of our higher production costs, it is difficult to see how we can compete with the Grecian article at Atlantic ports.

Three new plants were reported early in 1919 as preparing to make refractory brick here from California magnesite, one each at Porterville, Los Angeles, and Richmond. During 1917–1918, the output of the Refractory Magnesite Company at Preston, Sonoma County, was turned into bricks at the plant of the Stockton Fire and Enamel Brick Company, at Stockton, but the mine was closed in 1919. The mineral from this property is a natural ferro-magnesite and has found a ready market for refractory purposes. That from the White Rock Mine in Napa County also carries some iron.



Magnesite calcining furnace of Sinclair Bros., at Piedra, Fresno County. They report that by careful temperature regulation, using an electric pyrometer, they obtain caustic magnesite at 800°-900° with not to exceed 4% CO_2 remaining, yielding "a more active MgO." Capacity 25 tons of crude ore per day.

"NEEDS FOR STANDARDIZING THE DOMESTIC PRODUCT.[1]

"One of the most important factors in the success of Austrian magnesite has been the careful standardization of the finished product attained only by careful selection and preparation of the raw material, and skillful burning, whereby a product of uniform quality has been assured. Uniformity and close adherence to specifications undoubtedly have been important factors in the growth of both Austrian and Grecian business in the United States. These factors are called to the attention of certain of our domestic producers because laxity on the part of a few of them in these respects has caused some dissatisfaction among certain domestic consumers, and unfortunately an unsympathetic attitude toward them, at the present time.

"There were undoubtedly extenuating circumstances during the war period, among which was the sudden and urgent demand caused by the complete cutting off of the Austrian and Grecian product, together with a certain degree of inexperience in the business. The importance to our own producers of careful selection and care in burning can not be over-emphasized in the building up and maintenance of the domestic industry, and it is believed that the domestic producers are alive to the situation."

In 1918, for the first time since Tulare County became an important producer of this mineral, it was surpassed in tonnage output for the year, but regained the lead in 1919, followed by Santa Clara and Napa

[1]Phalen, W. C., Magnesite. In "Excerpts from monthly reports on minerals investigations in the Bureau of Mines, Department of the Interior," February, 1919.

counties, respectively. Approximately 17,600 tons were reported as shipped calcined, representing 35,200 tons of crude ore.

Production of crude magnesite for 1919, by counties, is given in the following table, with total crude value:

County	Tons	Value
Fresno	600	$5,950
Napa	10,112	86,752
Santa Clara	10,912	128,924
Stanislaus	2,031	20,831
Tulare	18,765	186,601
Riverside and San Benito*	2,276	23,036
Totals	44,696	$452,094

*Combined to conceal output of a single operator in each.

Annual production for California, amount and value, since 1887, is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	600	$9,000	1905	3,933	$16,221
1888	600	9,000	1906	4,032	40,320
1889	600	9,000	1907	6,405	57,720
1890	600	9,000	1908	10,582	80,822
1891	1,500	15,000	1909	7,942	62,588
1892	1,500	15,000	1910	16,570	113,887
1893	1,093	10,930	1911	8,858	67,430
1894	1,440	10,240	1912	10,512	105,120
1895	2,200	17,000	1913	9,632	77,056
1896	1,500	11,000	1914	11,438	114,380
1897	1,143	13,671	1915	30,721	283,461
1898	1,263	19,075	1916	154,052	1,311,893
1899	1,280	18,480	1917	209,648	1,976,227
1900	2,252	19,333	1918	83,974	803,492
1901	4,726	43,057	1919	44,696	452,094
1902	2,830	20,655			
1903	1,361	20,515	Totals	642,333	$5,841,965
1904	2,850	9,298			

MARBLE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38. U. S. Bur. of M., Bull. 106.

Marble is widely distributed in California, and in a considerable variety of colors and grain. During 1918, the production amounted to 25,020 cubic feet, valued at $74,482, from one operator in Inyo County, and two in Tuolumne. This shows a small increase both in amount and value from the previous year. This is considerably below what might be considered the normal output of former years, and certainly far below our possibilities. There are many varieties found in California suitable for all purposes of construction or decoration. Among the latter are deposits of onyx marble of beautiful coloring. There is also serpentine marble suitable for electrical switchboard use.

The decrease in output of marble in recent years is probably due in part to the fact that foreign, eastern and Alaskan marbles are landed here by water cheaper than much of our local stone can be put on the market, on account of our higher labor costs and transportation difficulties, though California has many beautiful and serviceable varieties. It is also due in part to the general curtailment of building activity on account of the war conditions.

New quarry being opened up by the Bell Marble Company, near Columbia, Tuolumne County. Photo by C. A. Logan.

Data on annual production since 1887, as compiled by the State Mining Bureau, follows. Previous to 1894 no records of amount were preserved:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887	----------	$5,000	1905	73,303	$129,450
1888	----------	5,000	1906	31,400	75,800
1889	----------	87,030	1907	37,512	118,066
1890	----------	80,000	1908	18,653	47,665
1891	----------	100,000	1909	79,600	238,400
1892	----------	115,000	1910	18,960	50,200
1893	----------	40,000	1911	20,201	54,103
1894	38,441	98,326	1912	27,826	74,120
1895	14,864	56,566	1913	41,654	113,282
1896	7,889	32,415	1914	25,436	48,832
1897	4,102	7,280	1915	22,186	41,518
1898	8,050	23,594	1916	25,954	50,280
1899	9,682	10,550	1917	24,755	62,950
1900	4,103	5,891	1918	*17,428	49,898
1901	2,945	4,630	1919	25,020	74,482
1902	19,305	37,616			
1903	84,624	97,354	Total value	----------	$2,129,506
1904	55,401	94,208			

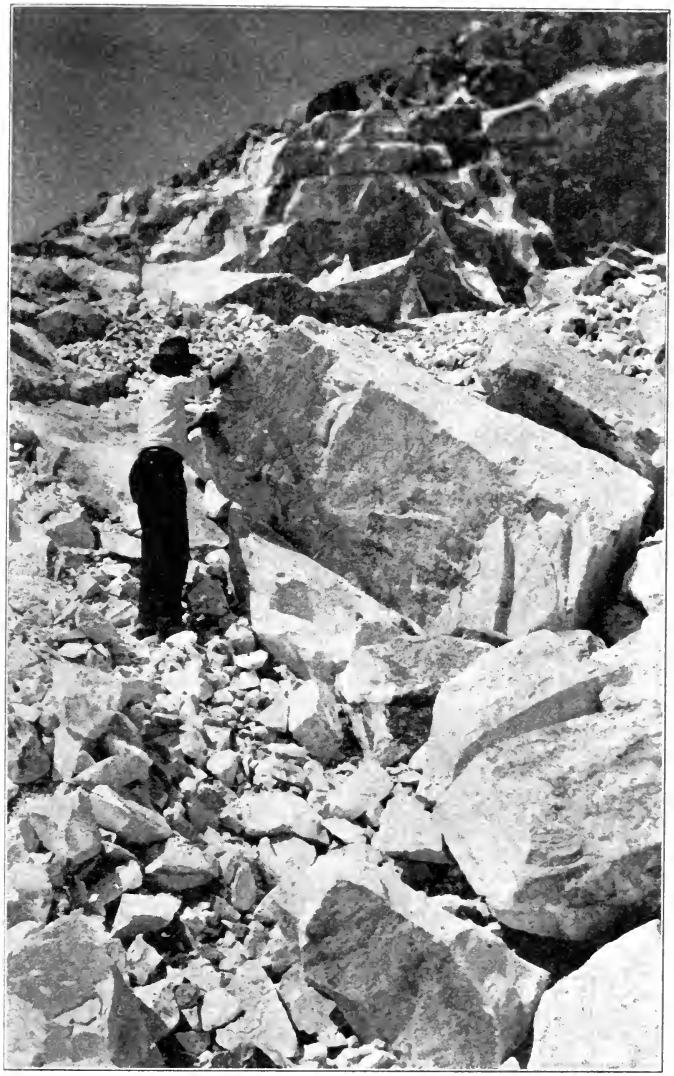
*Includes onyx and serpentine.

In quarry of Columbia Marble Company at Columbia, Tuolumne County, showing channeled faces. Photo by C. A. Logan.

ONYX and TRAVERTINE.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38.

Onyx and travertine are known to exist in a number of places in California, but there has been no production reported since the year 1896, except 1918. Some stone was shipped in 1918 from the Tolenas Springs onyx marble deposit in Solano County, and utilized for decorative purposes. As there was but a single operator, the figures were combined with those of the marble output for that year.



"Swansea White" marble in quarry of Inyo Marble Company, Inyo County. Photo by courtesy of the company.

Production by years was as follows:

Year	Value	Year	Value
1887	$900	1894	$20,000
1888	900	1895	12,000
1889	900	1896	24,000
1890	1,500	1918	*
1891	2,400	1919	
1892	1,800		
1893	27,000	Total	$91,400

*See under Marble.

SANDSTONE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38. U. S. Bur. of M., Bull. 124.

An unlimited amount of high-grade sandstone is available in California, but the wide use of concrete in buildings of every character, as well as the popularity of a lighter-colored building stone, has curtailed production in this branch of the mineral industry during recent years, almost to the vanishing point. In 1919 three counties—Amador, San Luis Obispo, and Ventura—turned out 5400 cubic feet, valued at $3,720, which is an increase over 1918, but considerably less than former years. The main feature of the loss since 1914 is the closing of the well-known Colusa quarries, on account of the competition of lighter-colored materials.

Amount and value, so far as contained in the records of this Bureau, are presented herewith, with total value from 1887 to date:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887	----------	$175,000	1905	302,813	$483,268
1888	----------	150,000	1906	182,076	164,068
1889	----------	175,598	1907	159,573	148,148
1890	----------	100,000	1908	93,301	55,151
1891	----------	100,000	1909	79,240	37,032
1892	----------	50,000	1910	165,971	80,443
1893	----------	26,314	1911	255,313	127,314
1894	----------	113,592	1912	66,487	22,574
1895	----------	35,373	1913	62,227	27,870
1896	----------	28,379	1914	111,691	45,322
1897	----------	24,086	1915	63,350	8,438
1898	----------	46,384	1916	17,270	10,271
1899	56,264	103,384	1917	31,090	7,074
1900	378,468	254,140	1918	900	400
1901	266,741	192,132	1919	5,400	3,720
1902	212,123	142,506			
1903	353,002	585,309	Total value	----------	$4,090,471
1904	363,487	567,181			

SERPENTINE.

Bibliography: Report XV. Bulletin 38.

Serpentine has not been produced in California to a very large extent at any time. A single deposit, that on Santa Catalina Island, has yielded the principal output to date. Some material was shipped from there in 1917 and 1918, being the first recorded since 1907. It was used for decorative building purposes and for electrical switchboards. As there was but a single operator, the figures were combined with those of marble output for those years.

The following table shows the amount and value of serpentine from 1895 as recorded by this Bureau:

Year	Cubic feet	Value	Year	Cubic feet	Value
1895	4,000	$4,000	1904	200	$2,310
1896	1,500	6,000	1905		
1897	2,500	2,500	1906	847	1,694
1898	750	3,000	1907	1,000	3,000
1899	500	2,000	1917	[1]	[1]
1900	350	2,000	1918	[2]	[2]
1901	89	890	1919		
1902	512	5,065			
1903	99	800	Totals	12,347	$33,259

[1]Under 'Unapportioned.'
[2]See under Marble.

SLATE.

Bibliography: Report XV. Bulletin 38.

Slate was first produced in California in 1889. Up to and including 1910 such production was continuous, there being none between that year and 1915. Large deposits of excellent quality are known in the state, especially in El Dorado, Calaveras and Mariposa counties, but the demand has been light owing principally to competition of cheaper roofing materials.

A square of roofing slate is a sufficient number of pieces of any size to cover 100 square feet of roof, with allowance generally for a three-inch lap. The size of the pieces of slate making up a square ranges from 7 x 9 inches to 16 x 24 inches, and the number of pieces in a square ranges from 85 to 686. It is worth $3.50 to $10 per square, f.o.b. quarry, depending on quality. The Ferry Building, San Francisco, is roofed with Eureka slate from El Dorado County.

A complete record of amount and value of slate produced in California follows:

Year	Squares	Value	Year	Squares	Value
1889	4,500	$18,089	1906	16,000	$100,000
1890	4,000	24,000	1907	7,000	60,000
1891	4,000	24,000	1908	6,000	60,000
1892	3,500	21,000	1909	6,961	45,660
1893	3,000	21,000	1910	1,000	8,000
1894	1,800	11,700	1911		
1895	1,350	9,450	1912		
1896	500	2,500	1913		
1897	400	2,800	1914		
1898	400	2,800	1915	1,000	5,000
1899	810	5,900	1916		
1900	3,500	26,250	1917		
1901	5,100	38,250	1918		
1902	4,000	30,000	1919		
1903	10,000	70,000			
1904	6,000	50,000	Totals	88,821	$676,399
1905	4,000	40,000			

MISCELLANEOUS STONE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38.

Miscellaneous stone is the name used throughout this report as the title for that branch of the mineral industry covering crushed rock of all kinds, paving blocks, sand and gravel, and pebbles for grinding mills. The foregoing are very closely related from the standpoint of the producer. Thus it has been found to be most satisfactory to group these items as has been done in recent reports of this Bureau. In so

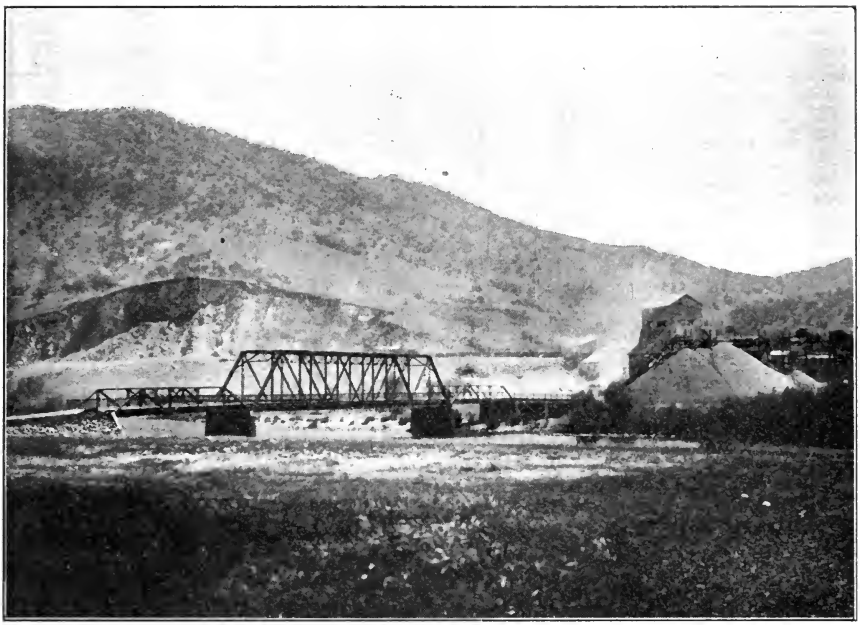
Plant of the Piedra Rock and Sand Company at Piedra, Fresno County, showing belt conveyor equipment for loading crushed rock from stack piles.

far as it has been possible to do so, crushed rock production has been subdivided into the various uses to which the product was put. It will be noted, however, a very large percentage of the output has been tabulated under the heading 'Unclassified.' This is necessary because of the fact that many of the producers have no way of telling to what specific use their rock was put after they have quarried and sold the same.

In addition to amounts produced by commercial firms, both corporations and individuals, there is hardly a county in the state but uses more or less gravel and broken rock on its roads. Of much of

this, particularly in the country districts, there is no definite record kept. Estimates have been made for some of this output, based on the mileage of roads repaired.

For the year 1919 miscellaneous stone shows a small increase in total value from the preceding year, being $3,698,944 as compared with $3,404,157 for 1918. The outlook for the current year, 1920, is not too encouraging, due to the curtailment of highway construction because of inability to sell the State Highway bonds at their present rate of interest.



Kings River Quarry and crusher plant of the Piedra Rock and Sand Company at Piedra, Fresno County. Capacity 1200 tons per day.

In 1919, as has been the case for a number of years past, Los Angeles County led all others by a wide margin, with an output valued at $715,524; followed by Alameda, second, with $309,572; Sacramento, third, $276,432; Contra Costa, fourth, $275,309; and Fresno, fifth, $241,213.

Paving Blocks.

The paving block industry has decreased materially of recent years, almost to the vanishing point, because of the increased construction of smoother pavements demanded by motor-vehicle traffic. The blocks made in Solano County were of basalt; those from Sonoma are of basalt, andesite, and some trachyte, while those from Placer, Riverside, San Bernardino, and San Diego are of granite.

Production in 1919 amounted to only 27 M., valued at $1,350, from a single producer, each, in Riverside, San Diego and Sonoma counties.

The amount and value of paving block production annually since 1887 has been as follows:

Year	Amount M.	Value	Year	Amount M.	Value
1887	*10,000	$350,000	1905	3,408	$134,347
1888	10,500	367,500	1906	4,203	173,432
1889	7,303	297,236	1907	4,604	199,347
1890	7,000	245,000	1908	7,660	334,780
1891	5,000	150,000	1909	4,503	199,803
1892	*3,000	96,000	1910	4,434	198,916
1893	2,770	96,950	1911	4,141	210,819
1894	2,517	66,981	1912	11,018	578,355
1895	2,332	73,338	1913	6,364	363,505
1896	4,161	77,584	1914	6,053	270,598
1897	1,711	35,235	1915	3,285	171,092
1898	1,144	21,725	1916	1,322	54,362
1899	305	7,861	1917	938	38,567
1900	1,192	23,775	1918	372	17,600
1901	1,920	41,075	1919	27	1,350
1902	3,502	112,437			
1903	4,854	134.642	Totals	135,510	$5,305,364
1904	3,977	161,752			

*Figures for 1887–1892 (inc.) are for Sonoma County only, as none are available for other counties during that period; though Solano County quarries were then also quite active.

Grinding Mill Pebbles.

Production of pebbles for tube and grinding mills began commercially in California in 1915. Owing to the decreased imports and higher prices of Belgium and other European flint pebbles, there has been a serious inquiry for domestic sources of supply. One of the shipments made in that year was of pebbles selected from gold-dredger tailings in Sacramento County, for use in a gold mill in Amador County employing Hardinge mills.

The important development in this item, however, has been in San Diego County. At several points along the ocean shore from Encinitas south to near San Diego, there are beaches of washed pebbles varying from 1 inch to 6 inches in diameter, which came from conglomerate beds made up of well-rounded water-worn pebbles of various granitic and porphyritic rocks with some felsite and flint. The wave action has broken down portions of the cliffs for considerable distances and formed beaches of the pebbles which are well washed and cleaned of the softer materials. The rocks sorted out for shipment are mainly basalt and diabase, with an occasional felsite and flint pebble. There is a tough black basalt which is stated to be giving satisfactory results. In Fresno County pebbles have been selected from the gravel beds of the San Joaquin River near Friant. Shipments have been made to metallurgical plants in California, Nevada, Montana and Utah.

There was some resumption of imports in 1919, amounting to 17,677 tons, valued at $250,096, but the California pebbles still continue to supply a part of the local demand. Though several parties were engaged in this business in San Diego County in 1917–1919, at present (March, 1920), the number is reduced to a single operator. The output for 1919 was 2607 tons, valued at $19,272, all from San Diego County. The prices varied from $4 to $10 per ton, f.o.b. shipping point, according to quality, size and shape, the average being about $8 per ton.

The amount and value of grinding mill pebbles, annually, follows:

Year	Tons	Value
1915	340	$2,810
1916	20,232	107,567
1917	21,450	90,538
1918	8,628	61,268
1919	2,607	19,272
Totals	53,257	$281,455

Sand and Gravel Production, by Counties, 1919.

County	Tons	Value	County	Tons	Value
Alameda	[1]342,577	$188,645	Sacramento	[1]75,428	$49,103
Alpine	150	100	San Benito	48,000	32,500
Calaveras	2,000	600	San Bernardino	276,727	115,520
Colusa	11,000	4,900	San Diego	[1]290,691	100,175
Contra Costa	26,578	8,781	San Joaquin	130,119	59,510
Del Norte	10,000	6,000	San Luis Obispo	17,300	10,800
El Dorado	200	200	San Mateo	15,281	10,411
Fresno	373,918	164,613	Santa Barbara	8,934	6,400
Glenn	407,611	58,137	Santa Clara	96,971	52,237
Humboldt	26,729	22,499	Santa Cruz	17,000	8,700
Imperial	2,800	1,500	Shasta	18,667	10,750
Inyo	2,300	3,150	Sierra	1,333	750
Kern	107,800	23,820	Siskiyou	36,270	12,037
Lake	2,000	1,200	Sonoma	161,666	45,626
Los Angeles	824,589	377,805	Stanislaus	34,985	28,522
Marin	28,667	14,333	Tehama	8,000	7,500
Mariposa	500	200	Trinity	633	825
Mendocino	13,333	5,000	Tulare	24,000	10,211
Merced	50,000	27,600	Tuolumne	3,000	1,500
Modoc	500	250	Ventura	10,000	5,000
Monterey	[2]93,953	73,031	Yolo	8,500	5,600
Napa	107,890	60,346	Yuba	123,266	39,839
Nevada	3,320	756	Butte, Placer,[3] Solano*	97,787	26,221
Orange	8,653	1,944			
Plumas	500	250			
Riverside	13,604	9,030	Totals	3,965,730	$1,694,427

*Combined to conceal output of a single operator in each.
[1]Includes moulding sand.
[2]Includes moulding, building, filter, and roofing sand.
[3]Includes foundry core sand.

Crushed Rock Production, by Counties, for 1919.

County	Macadam and ballast		Rubble and riprap		Concrete		Unclassified		Totals	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
Alameda	38,995	$32,905	224	$168	94,061	$82,343	[1]10,013	$5,511	143,293	$120,927
Contra Costa	19,531	15,595			67,109	50,332	281,111	200,601	367,751	266,528
Del Norte	500	300							500	300
El Dorado	1,000	1,500							1,000	1,500
Fresno	18,700	10,350							18,700	10,350
Humboldt							1,202	2,699	1,202	2,699
Imperial			266,600	54,000			5,600	8,400	272,200	62,400
Inyo					2,650	4,700			2,650	4,700
Kern					2 250	4.500			2,250	4,500
Lassen	1,333	1,100							1,333	1,100
Los Angeles					142,227	90,750	165,280	137,996	307,507	228,746
Madera	2,000	1,500							2,000	1,500
Marin			7,673	7,887					7,673	7,887
Mariposa	500	200							500	200
Mendocino	3,000	2,000							3,000	2,000
Modoc	500	300							500	300
Napa	6,560	6,130			4,347	3,540			10,907	9,670
Nevada	4,880	1,100	160	120					5,040	1,220
Placer	1,000	400	1,218	330					2,218	730
Plumas	1,000	600							1,000	600
Riverside			33,412	36,533			[2]84,528	56,486	117,940	93,019
Sacramento			70,068	2,102			303,300	225,227	373,368	227,329
San Bernardino			14,280	8,568			97,700	59,300	111,980	67,868
San Diego	5,000	2,000	3,610	2,533					8,610	4,533
San Luis Obispo	5,000	6,000			700	3,500			5,700	9,500
San Mateo	17,939	18,931			8,016	9,018	4,167	3,875	30,122	31,824
Santa Barbara	21,333	23,500							21,333	23,500

Santa Cruz	3,000	2,000			4,893	6,374			7,893	8,374
Shasta	26,000	21,000							26,000	21,000
Siskiyou	67,595	14,368							67,595	14,368
Sonoma	15,378	13,115	397	260	47	35			15,822	13,410
Stanislaus							533	400	533	400
Tulare	1,000	600							1,600	600
Tuolumne	2,000	1,200							2,000	1,200
Yuba	1,000	600							1,000	600
San Benito, San Francisco, Santa Clara, Solano*	302,333	151,200								
Los Angeles, Merced, San Francisco, Trinity*			120,789	132,937	120					
Fresno, Marin, San Benito, San Diego, San Francisco, Santa Clara*					278,346	216,007				
Butte, Fresno, San Francisco, Santa Clara, Solano, Sonoma*							309,870	238,369	1,011,338	1,245,382
Totals	567,077	$328,494	518,431	$245,438	604,646	$471,099	1,263,304	$938,864	2,953,458	$1,983,895

*Combined to conceal output of a single operator in each.
[1]Includes red shale utilized for roofing and linoleum.
[2]Includes a green rock, locally called 'slate,' utilized for roofing preparations.

A comparison of the table of annual productions of these materials with the similar table for cement (see *ante*), reveals the fact that the important growth of the crushed rock and gravel business was coincident with the rapid development of the cement industry from the year 1902.

Sand and gravel plant of Fresno Rock Products Company, at Woodrock, on the Kings River, Fresno County. Capacity 700 tons per day.

The amount and value, annually, of crushed rock (including macadam, ballast, rubble, riprap, and that for concrete), and sand and gravel, since 1893, follow:

Crushed Rock, Sand and Gravel, by Years.

Year	Tons	Value	Year	Tons	Value
1893	371,100	$456,075	1908	3,998,945	$3,241,774
1894	661,900	664,838	1909	5,531,561	2,708,326
1895	1,254,688	1,095,939	1910	5,827,828	2,777,690
1896	960,619	839,884	1911	6,487,223	3,610,357
1897	821,123	600,112	1912	8,044,937	4,532,598
1898	1,177,365	814,477	1913	9,817,616	4,823,056
1899	964,898	786,892	1914	9,288,397	3,960,973
1900	789,237	561,642	1915	10,879,497	4,609,278
1901	530,396	641,037	1916	9,951,089	4,009,590
1902	2,056,015	1,249,529	1917	8,069,271	3,505,662
1903	2,215,625	1,673,591	1918	6,641,144	3,325,889
1904	2,296,898	1,641,877	1919	6,919,188	3,678,322
1905	2,624,257	1,716,770			
1906	1,555,372	1,418,406	Totals	112,025,127	$60,859,599
1907	2,288,888	1,915,015			

Total Value of Production of 'Miscellaneous Stone' (Crushed Rock, Sand, Gravel, Paving Blocks and Grinding Mill Pebbles), by Counties, for 1919.

County	Value	County	Value
Alameda	$309,572	Plumas	$850
Alpine	100	Riverside	102,399
Butte	92,765	Saeramento	276,432
Calaveras	600	San Benito	164,300
Colusa	4,900	San Bernardino	183,388
Contra Costa	275,309	San Diego	141,996
Del Norte	6,300	San Francisco	65,541
El Dorado	1,700	San Joaquin	59,510
Fresno	241,213	San Luis Obispo	20,300
Glenn	58,137	San Mateo	42,235
Humboldt	25,198	Santa Barbara	29,900
Imperial	63,900	Santa Clara	73,237
Inyo	7,850	Santa Cruz	17,074
Kern	28,320	Shasta	31,750
Lake	1,200	Sierra	750
Lassen	1,100	Siskiyou	26,405
Los Angeles	715,524	Solano	44,156
Madera	1,500	Sonoma	144,014
Marin	127,111	Stanislaus	28,922
Mariposa	400	Tehama	7,500
Mendocino	7,000	Trinity	11,839
Merced	40,350	Tulare	10,811
Modoc	550	Tuolumne	2,700
Monterey	73,031	Ventura	5,000
Napa	70,016	Yolo	5,600
Nevada	1,976	Yuba	40,439
Orange	1,944		
Placer	4,330	Totals	$3,698,944

CHAPTER FIVE.

INDUSTRIAL MATERIALS.

Bibliography: Reports XIV, XV. Bulletin 38. Min. & Sci. Press, Vol. 114, March 10, 1917.

The following mineral substances have been arbitrarily arranged under the general heading of Industrial Materials, as distinguished from those which have a clearly defined classification, such as metals, salines, structural materials, etc.

These materials, many of which are mineral earths, are, with four or five exceptions, as yet produced on a comparatively small scale. The possibilities of development along several of these lines are large and with increasing transportation and other facilities, together with steadily growing demands, the future for this branch of the mineral industry in California is certainly promising. There is scarcely a county in the state but might contribute to the output.

Up to within the last few years, at least, production has been in the majority of instances dependent upon more or less of a strictly local market, and the annual tables show the results of such a condition, not only in the widely varying amounts of a certain material produced from year to year, but in widely varying prices of the same material. Furthermore, the quality of this general class of material will be found to fluctuate, even in the same deposit. The war in Europe affected some of these items, but not to the striking degree that it did the metal markets.

The more important of these minerals thus far exploited, so far as shown by annual value of the output, are limestone, mineral water, pyrite, pottery clays, and diatomaceous earth.

The following summary shows the value of the industrial materials produced in California during the years 1918–1919, with increase or decrease in each instance:

Substance	1918		1919		Increase + Decrease — Value
	Amount	Value	Amount	Value	
Asbestos	*	*	*	*	* —
Barytes	100 tons	$1,500	1,501 tons	$18,065	$16,565+
Clay (pottery)	112,423 tons	166,788	135,708 tons	245,019	78,231+
Dolomite	24,560 tons	79,441	24,502 tons	67,953	11,488—
Feldspar	4,132 tons	22,061	1,272 tons	12,965	9,096—
Fluorspar	*	*			* —
Fuller's earth	37 tons	333	385 tons	3,810	3,477+
Gems		650		5,425	4,775+
Graphite	*	*	*	*	* +
Gypsum	19,695 tons	37,176	19,813 tons	50,579	13,403+
Infusorial and diatomaceous earths	35,963 tons	189,459	40,200 tons	217,800	28,341+
Limestone	208,566 tons	456,258	88,291 tons	248,145	208,113—
Lithia	4,111 tons	73,998	800 tons	14,400	59,598—
Mineral paint	728 tons	4,738	1,780 tons	17,055	12,317+
Mineral water	1,808,791 gals.	375,650	2,233,842 gals.	340,117	35,533—
Pumice and volcanic ash	2,114 tons	28,639	2,388 tons	43,657	14,988+
Pyrite	128,329 tons	425,012	147,024 tons	540,300	115,288+
Silica (sand and quartz)	23,257 tons	88,930	18,659 tons	101,600	12,670+
Soapstone and talc	11,760 tons	85,534	8,764 tons	115,091	29,557+
Strontium	2,900 tons	33,000			33,000—
Asbestos, fluorspar, graphite*		14,007		19,500	5,493+
Total value		$2,083,204		$2,061,481	
Net decrease					$21,723—

*Combined to conceal output of a single operator in each.

ASBESTOS.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38. Canadian Dept. of M., Mines Branch Bulletin 69. Min. and Sci. Press, April 10, 1920, pp. 531–533.

Though asbestos of various grades is known in several localities in California, the production thus far is still small. For the year 1919, as there was only a single producer, the figures are concealed under the 'Unapportioned' item. There was, however, a smaller tonnage produced which brought a higher price per ton than in 1918. From Nevada County some small shipments of spinning fiber were sent East; but the main part of the output was utilized locally in magnesite-cement stucco, steam-pipe covering, and flooring.

The Nevada County material yields a good proportion of medium-length chrysotile with some high-grade spinning fiber. The Sierra Asbestos Company has opened up a promising deposit there, and is milling its rock in an old 20-stamp gold mill converted to their purposes, to which fiberizing machinery has been added. Chrysotile of good-quality fiber, though short, has also been found in Calaveras, Fresno, Lake and Trinity counties.

The bulk of the world's supply of this mineral comes from Canada; and Canadian asbestos, so far, leads in length of fiber as well as in quality.

Classification and Characteristics.

The word asbestos (derived from the Greek, meaning incombustible) as used here includes several minerals, from a strictly mineralogical standpoint. There are two main divisions, however; amphibole and chrysotile. The fibrous varieties of several of the amphiboles (silicates chiefly of lime, magnesia and iron), notably tremolite and actinolite, are called asbestos. Their fibres usually lie parallel to the fissures containing them. Amphibole asbestos possesses high refractory properties, but lacks strength of fibre, and is applicable principally for covering steam pipes and boilers. Chrysotile, a hydrous silicate of magnesia, is a fibrous form of serpentine, and often of silky fineness. Its fibres are formed at right angles to the direction of the fissures containing them. Chrysotile fibres, though short, have considerable strength and elasticity, and may be spun into threads and woven into cloth. To bring the highest market price asbestos must needs have a combination of properties, *i. e.*, length and fineness of fibre, tensile strength and flexibility—all combined with infusibility. Of these qualities the most important are toughness and infusibility, and determination of the same can only be made by practical tests or in the laboratory.

Asbestos, roughly speaking, was worth from $20 to $200 per ton, before the war. Under the stimulus of war conditions, the demand has caused a material increase in prices. The poorer grades which are unsuitable for weaving and which, of course, command the lower prices, are used in the manufacture of steam packing, furnace linings, asbestos brick, wall plasters, paints, tiling, asbestos board, shingles, insulating material, magnesite-stucco, etc. The better grades are utilized in the manufacture of tapestries of various kinds, fireproof theater curtains, cloth, rope, etc.

A very important development of the asbestos industry is the rapidly increasing demand for the lower grade material, on account of the numerous diversified uses to which asbestos products are being put, in almost every branch of manufacture. This fact means that many deposits of asbestos will become commercially important even though the grade of the material is far from the best.

It has been found that not only does an asbestos wall-plaster render the wall so covered impervious to heat, but that in rooms which have given forth an undesirable echo this evil has been absolutely removed. Asbestos pulp mixed with magnesite-cement has been experimented with; and roofing, flooring, and other building material of the most satisfactory sort has been manufactured therefrom.

Value and Production.

Total amount and value of asbestos production in California since 1887, as given in the records of this Bureau, are as follows:

Year	Tons	Value	Year	Tons	Value
1887	30	$1,800	1905	112	$2,625
1888	30	1,800	1906	70	3,500
1889	30	1,800	1907	70	3,500
1890	71	4,260	1908	70	6,100
1891	66	3,960	1909	65	6,500
1892	30	1,830	1910	200	20,000
1893	50	2,500	1911	125	500
1894	50	2,250	1912	90	2,700
1895	25	1,000	1913	47	1,175
1896	------	------	1914	51	1,530
1897	------	------	1915	143	2,860
1898	10	200	1916	145	2,380
1899	30	750	1917	136	10,225
1900	50	1,250	1918	229	9,903
1901	110	4,400	1919	*	*
1902	------	------			
1903	------	------	Totals	2,145	$101,460
1904	10	162			

*Under Unapportioned.

BARYTES.

Bibliography: State Mineralogist Reports XII, XIV, XV. Bulletin 38.

The output of crude barytes during 1919 was 1,501 tons, valued at $18,065 as compared with the 1918 production of 100 tons, worth $1,500. This mineral is ordinarily sorted and ground before being put on the market. The principal use for barytes is in the paint industry; also in certain rubber articles. For the former purpose, the material should show pure white after grinding. Lithopone is a chemically prepared white pigment containing about 70% barium sulphate and 30% zinc sulphide, and is one of the principal constituents of 'flat' wall paints now so extensively used in office buildings and hospitals, replacing both paper and calcimine wall finishes. Minor uses are in tanning of leather, manufacture of paper and rope, and sugar refining.

Known occurrences of this mineral in California are located in Inyo, Los Angeles, Mariposa, Monterey, Nevada, San Bernardino, Shasta, and Santa Barbara counties. The deposit at El Portal, in Mariposa County, has given the largest commercial production to date, in part, witherite (barium carbonate, $BaCO_3$), though idle in 1919. The 1915 output was the first commercial production of the carbonate in the United States, of which we have record. In 1916, output began from

a deposit opened up on Fremont's Peak, Monterey County, near the line of San Benito County. The 1919 shipments were mainly from Monterey and Nevada counties, with a small trial shipment from Shasta County.

The first recorded production of barytes in California, according to the statistical reports of the State Mining Bureau, was in 1910. The annual figures are as follows:

Year	Tons	Value	Year	Tons	Value
1910	860	$5,640	1916	1,606	$5,516
1911	309	2,207	1917	4,420	25,633
1912	564	2,812	1918	100	1,500
1913	1,600	3,680	1919	1,501	18,065
1914	2,000	3,000			
1915	410	620	Totals	13,370	$68,673

CLAY—POTTERY.

Bibliography: State Mineralogist Reports I, IV, IX, XII, XIII, XIV, XV. Bulletin 38. Preliminary Report, No. 7.

At one time or another in the history of the state, pottery clay has been quarried in thirty-three of its counties. In this report pottery clay refers to all clays used in the manufacture of red and brown earthenware, flowerpots, ornamental tiling, architectural terra cotta, sewer pipe, etc., and the figures for amount and value are relative to the crude material at the pit, without reference to whether the clay was sold in the crude form, or whether it was immediately used in the manufacture of any of the above finished products by the producer. It does not include clay used in making brick and building blocks.

During 1919 a total of 36 producers in 12 counties reported an output of 135,708 tons of clay, having a spot value of $245,019 for the crude material, at the pits, as compared with the 1918 production of 112,423 tons worth $166,788.

A tabulation of the direct returns from the producers, by counties, for the year 1919, is shown herewith:

County	Tons	Value	Used in manufacture of—
Alameda	[1]5,011	$12,127	Architectural terra cotta, building blocks, and sewer pipe.
Amador	[2]20,653	55,523	Architectural terra cotta, porcelain ware, fire-clay ware, stoneware, pottery, sewer pipe; also some kaolin used in insecticide tree spray.
Los Angeles	[3]11,529	33,343	Architectural terra cotta, sanitary and stoneware, floor, faience, roofing and drain tile, sewer and water pipe.
Placer	45,727	60,713	Fire-clay ware, floor, drain and roofing tile, architectural terra cotta, sewer and chimney pipe, flue lining, lead pots, sanitary ware.
Riverside	42,207	61,006	Fire-clay ware, chimney and flue lining, sewer pipe.
San Diego	[4]762	4,929	Chemical stoneware and architectural terra cotta.
Santa Clara	2,532	2,232	Red earthenware and sewer pipe.
Contra Costa, Humboldt, Orange, Sacramento, San Bernardino, Ventura*	7,487	15,146	Mantel and drain tile, porcelain, sewer pipe.
Totals	135,708	$245,019	

[1]Includes 'fireclay brick dust.'
[2]Includes washed kaolin and ball clay.
[3]Includes crushed brick.
[4]Includes 'Cornwall stone,' used for pottery; also halloysite used in oil refining.
*Combined to conceal output of a single operator in each.

Because of the fact that a given product often requires a mixture of several different clays, and that these are not all found in the same pit, it is necessary for most clay-working plants to buy some part of their raw materials from other localities. For these reasons, in compiling the clay industry figures, much care is required to avoid duplications. So far as we have been able to segregate the figures, from the data sent in by the operatives, we have credited the clay output to the counties from which the raw material originated; and have deducted tonnages used in brick manufacture, as bricks are classified separately, herein.

The values of the various pottery clay products made in California during 1919, totaled $2,076,280 compared with $1,687,902 in 1918, their distribution being shown in the following tabulation:

Values of Pottery Clay Products, 1919.

Product	Number of producers	Value
Architectural terra cotta	7	$207,142
Chimney pipe, terra cotta, and flue linings	5	56,547
Drain tile	10	78,724
Roofing tile	3	127,770
Sewer pipe	8	779,079
Stoneware and sanitary ware	7	625,464
Red earthenware	3	81,500
Floor and faience tile	5	16,074
Miscellaneous, including bisque ware, doll heads, art pottery, mantel tile, porcelain, hotel and dinner ware, garden furniture, water and conduit pipe and lead pots	8	103,980
Total value		$2,076,280

A recent and unique addition to the pottery industry of California is the making of bisque doll heads by the California China Company at Berkeley. The plant was built in 1916, but made no commercial output until 1919. This is stated to be the only firm in the United States at present producing and selling bisque doll heads on a commercial scale. Before the war, such articles were imported from Germany. This plant is using mainly California clays, silica, and feldspar.

Amount and value of crude pottery clay output in California since 1887 are given in the following table:

Year	Tons	Value	Year	Tons	Value
1887	75,000	$37,500	1905	133,805	$130,146
1888	75,000	37,500	1906	167,267	162,283
1889	75,000	37,500	1907	160,385	254,454
1890	100,000	50,000	1908	208,042	325,147
1891	100,000	50,000	1909	299,424	465,647
1892	100,000	50,000	1910	249,028	324,099
1893	24,856	67,284	1911	224,576	252,759
1894	28,475	35,073	1912	199,605	215,683
1895	37,660	39,685	1913	231,179	261,273
1896	41,907	62,900	1914	179,948	167,552
1897	24,592	30,290	1915	157,866	133,724
1898	28,947	33,747	1916	134,636	146,538
1899	40,600	42,700	1917	166,298	154,602
1900	59,636	60,956	1918	112,423	166,788
1901	55,679	39,144	1919	135,708	245,019
1902	67,933	74,163			
1903	90,972	99,907	Totals	3,870,596	$4,336,015
1904	84,149	81,952			

DOLOMITE.

Bibliography: Report XV. Bulletin 67.

Previous to the 1915 report dolomite was included under limestone. Limestones are frequently more or less magnesian-bearing, and a chemical analysis is often necessary to definitely decide as to whether they

are calcite or dolomite; the latter standing intermediate between magnesite ($MgCO_3$) and calcite ($CaCO_3$). Since dolomite, as such, has been found to have certain distinctive applications, we have deemed it worthy of a separate classification.

The major portion of the tonnage being shipped is utilized as a refractory lining in the bottoms of open-hearth steel furnaces, as a substitute for magnesite. A portion is used for its carbonic acid gas (CO_2), and part for its magnesia. We are also informed that some calcined dolomite has been used by the paper mills. As the San Benito and Monterey dolomite has been found to contain the proper proportions of lime and magnesia, it can replace an artificial mixture of calcined limestone and magnesite in the manufacture of paper from wood pulp. Dolomite is also sometimes used as a flux in metal smelting.

The production of dolomite for the year 1919 amounted to 24,502 tons, valued at $67,953, and came from a total of 6 quarries in 4 counties, distributed as follows:

County	Tons	Value
Monterey	8,280	$29,120
San Benito	7,000	24,500
Inyo and San Bernardino*	9,222	14,333
Totals	24,502	$67,953

*Combined to conceal output of a single operator in each.

Amount and value of the output of dolomite, annually, have been as follows:

Year	Tons	Value
1915	4,192	$14,504
1916	13,313	46,566
1917	27,911	66,416
1918	24,560	79,441
1919	24,502	67,953
Totals	94,478	$274,880

FELDSPAR.

Bibliography: Report XV. Bulletin 67. U. S. Bur. of M., Bull. 92.

Feldspar was produced by a single operator in each of three counties during 1919, Monterey, Riverside and Tulare, to the amount of 1272 tons, valued at $12,965.

Feldspar production only dates back to 1910 in California. The mineral is a constituent of many rocks, but can only be commercially produced from pegmatites where the crystals are large and quite free from impurities. The open-cut method of mining this material is commonly used. Manufacturers of enamel wares and pottery buy most of the better grades of feldspar produced. Small quantities are used in the manufacture of glass and scouring soaps, and the more impure material is used as chicken grit, in making various brands of roofing, and in other ways. Various experiments have been made with the potash feldspars in the attempt to extract their potash content for use in fertilizers. The most successful of these has been accomplished through the medium of cement manufacture, and recovery of the potash as a by-product.

[1]"The requirements of the pottery trade demand that in general the percentage of free quartz associated with the feldspar used for this purpose shall not exceed 20 per cent in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent of free quartz. In order to be profitably worked in most feldspar mines between one-fourth and one-half of the total material that must be excavated should contain less than 20 per cent of free quartz. Freshness of the feldspar, though desirable, is not essential.

"A factor of the utmost importance in the mining of pottery spar is the quantity of iron-bearing minerals (black mica, hornblende, garnet, black tourmaline, etc.) present and the manner in which these minerals are associated with the feldspar. The requirements of the pottery trade demand that the spar be nearly free from these minerals. In order that a deposit may be worked profitably these minerals, if present in any appreciable quantity, must be so segregated in certain portions of the deposit that they can be separated from the spar without much more hand sorting and cobbing than is necessary anyway in the separation of the highly feldspathic material from that which is highly quartzose or rich in muscovite. The presence here and there of minute flakes of white mica (muscovite) is characteristic even of the highest grades of commercial feldspar, and this mineral is not injurious except in so far as it is exceedingly difficult to pulverize the thin, flexible mica plates to a fineness equal to that required in the feldspar, and it is therefore necessary in mining to separate carefully as much of the muscovite as possible from the spar.

"Recently potash feldspars have been sought as a source of potash salts and also by reason of their potash content for incorporation in so-called complete fertilizers. For such purposes the prices paid are generally less than for pottery feldspar of first and second grade, and if such use of feldspar is found practicable the quantities required will be far in excess of those heretofore annually required by the pottery industries. To supply such a demand pegmatite deposits must be of large size and very favorably located with respect to transportation facilities and market.

"The requirements for extraction of potash and for use in fertilizer are a high potash content and convenience of location. The presence of quartz and of iron-bearing and other minerals in small quantities is of no significance. Both white and black mica are potash-bearing minerals and therefore not wholly undesirable.

"Almost any coarse, undecomposed granite pegmatite is adapted to the manufacture of roofing materials and poultry grit, but these products command such low prices that they can be marketed only under very favorable conditions."

Total amount and value of feldspar production in California since the inception of the industry are given in the following table, by years:

Year	Tons	Value	Year	Tons	Value
1910	760	$5,720	1916	2,630	$14,350
1911	740	4,560	1917	11,792	46,411
1912	1,382	6,180	1918	4,132	22,061
1913	2,129	7,850	1919	1,272	12,965
1914	3,530	16,565			
1915	1,800	9,000	Totals	30,167	$145,657

[1]Katz, F. J., Feldspar in 1916: U. S. Geol. Surv., Min. Res. of U. S., 1916, Part II, p. 175, 1917.

FLUORSPAR.

Bibliography: Bulletin 67.

Fluorspar is used as a flux in steel and iron smelting, and in the production of aluminum. It is also utilized in the manufacture of hydrofluoric acid, glass, porcelain, enamels and sanitary ware.

[1]"The market for the bulk of the fluorspar sold in the United States depends on the steel industry and the demand fluctuates with the rise and fall in the production of steel. Gravel spar is consumed as a flux in basic open-hearth steel furnaces and to a smaller extent in other metallurgical operations. In both 1914 and 1915 the sales of gravel spar constituted between 83 and 84 per cent of the total marketed output of domestic fluorspar, and in 1916 it was nearly 86 per cent. Fluorspar is used also as a flux in iron blast furnaces, iron foundries, and in gold, silver, copper, and lead smelters; in the manufacture of fluorides of iron and manganese for steel fluxing and of sodium fluoride for wood preservation[2]; in the manufacture of glass, enameled, and sanitary ware, and of hydrofluoric acid; in the electrolytic refining of antimony and lead; and in the production of aluminum. Other miscellaneous uses of fluorspar that have been reported are as a bonding for constituents of emery wheels, for carbon electrodes, in the extraction of potash from feldspar, and in the recovery of potash in Portland cement manufacture. The last use depends on the suitability of calcium fluoride as a reagent for increasing the volatilization of potassium salts from the clinker and the regeneration of the reagent from the dust collected.[3]"

In California, deposits have been reported in Los Angeles, Mono, Riverside, and San Bernardino counties, but up to 1917 no commercial production had resulted. As the 1917–1918 output came from a single operator in Riverside County, the amount and value were concealed under the Unapportioned item. There was none shipped in 1919. Production has been started this year (1920) at the King mine near Afton in San Bernardino County, on what promises to become an important source, commercially, of this mineral. Analyses reported show an average of over 90% calcium fluoride (CaF_2).

FULLER'S EARTH.

Bibliography: Bulletin 38. U. S. Bureau of Mines, Bulletin 71.

Fuller's earth production in California during the year 1919 amounted to 385 tons, valued at $3,810, as compared with 37 tons valued at $333 in 1918.

This material is soft and friable, and, in general, resembles a clay, but is non-plastic. It has no definite mineralogical composition and its commercial value is determined by its physical properties, i. e., texture, and filtering and absorbent properties.

[4]"The Shipping Board's inquiries also brought out the interesting information that only domestic fuller's earth is used for the refining of mineral oils. There appears, on the other hand, to be a difference of opinion as to the suitability of the domestic earth for use in refining edible oils. Some of the larger users of fuller's earth, anticipating a shortage of imported materal, began early in the war to experiment with domestic earths in refining edible oils and fats, with results so satisfactory that they became independent of imported earth. Others stated that they had experimented with every known domestic earth, but had not found one that completely met the

[1]Burchard, E. F., Fluorspar and cryolite in 1916: U. S. Geol. Surv., Min. Res. of U. S., 1916, Part II, p. 315, 1917.

[2]Teesdale, C. H., Use of fluorides in wood preservation: Wood Preserving, vol. 3, No. 4; vol. 4, No. 1. (Reprint, 9 pp.)

[3]Treanor, John, Potash from cement at the Riverside Portland Cement Co.: Met. and Chem. Eng., June 15, 1917, pp. 701–703.

[4]Middleton, Jefferson, Fuller's Earth in 1918: U. S. Geol. Surv., Min. Res. of U. S., 1918, Part II, p. 136, 1919.

requirements to supplant the imported earth. The requirements of a good earth for refining edible oils are (1) that it shall bleach well and that the oil shall not revert to its original color; (2) that it shall filter well and not cake badly; (3) that it shall leave no permanent disagreeable taste or odor; (4) that the retention of oil in the spent earth shall be small; and (5) that there shall be no spontaneous ignition either in the press or in the waste piles. Those who use the imported earth claim that it is standard in all of these requirements, and that the domestic earth is deficient in one or more of them. Such a defect as inability to bleach well appears to be inherent in some domestic earth, and can not be remedied by treatment. Other defects, such as the taste or odor left by the earth, which is the most frequent objection urged against the domestic material, may possibly be overcome by treatment. Another serious fault charged against the American earth is that it retains a greater proportion of oil than the English earth, which means a direct loss in production; also that it clogs the filter presses more, so that they require more frequent cleaning, which causes further decrease in production. It is also charged that domestic earth is more subject to spontaneous combustion."

In California, fuller's earth is used in clarifying both refined mineral and vegetable oils, although its original use was in fulling wool, as the name indicates. Some of the 1919 product was used for special chemical purposes. Production has mainly come from Calaveras and Solano counties. Deposits have also been found in Riverside, Fresno and Kern counties. The 1919 output was from Kern, Riverside and Solano.

It was first produced commercially in this state in 1899, and the total amount and value of the output since that time are as follows:

Year	Tons	Value	Year	Tons	Value
1899	620	$12,400	1911	466	$5,294
1900	500	3,750	1912	876	6,500
1901	1,000	19,500	1913	460	3,700
1902	987	19,246	1914	760	5,928
1903	250	4,750	1915	692	4,002
1904	500	9,500	1916	110	550
1905	1,344	38,000	1917	220	2,180
1906	440	10,500	1918	37	333
1907	100	1,000	1919	385	3,810
1908	50	1,000			
1909	459	7,385	Totals	10,596	$163,148
1910	340	3,820			

GEMS.

Bibliography: State Mineralogist Reports II, XIV, XV. Bulletins 37, 67.

Accounting for the production of gems in California is somewhat unsatisfactory, owing to the widely scattered places at which stones are gathered and marketed in a very small way. The following table shows the production, by counties, of rough uncut materials during 1919:

County	Value	Kind
Butte	*$5,425	Diamonds.
Los Angeles		Beach stones (jasper and chalcedony).
San Bernardino		Bloodstone, blue chalcedony and myrickite.
San Diego		Tourmaline.

*Combined to conceal output of a single operator in each.

The yield has been small for several years past. California tourmalines are decidedly distinctive in coloring and 'fire' as compared to foreign stones of this classification. The colors range from deep ruby to pink, and various shades of green; also more recently a blue tourmaline has been found.

Two of our California gem stones, kunzite and benitoite, are not found elsewhere; and these, each in but a single locality here: the former in the Pala Chief Mine in San Diego County, and the latter in the Dallas Mine in San Benito County.

Californite, or 'California jade,' is a gem variety of vesuvianite, and is green or white in color.

Some rhodonite has been mined in Siskiyou County, and used for decorative purposes, its value being included in the marble figures.

Diamonds have been found in a number of localities in California; but in every case, they have been obtained in stream gravels while working them for gold. The principal districts have been: Volcano in Amador County; Placerville, Smith's Flat and others in El Dorado County; French Corral, Nevada County; Cherokee Flat and Yankee Hill, Butte County; Gopher Hill and upper Spanish Creek, Plumas County. The most productive district of recent years has been Cherokee in Butte County.

Chrysoprase has been produced in Tulare County.

The value of the total gem production in California annually since the beginning of commercial production is as follows:

Year	Value	Year	Value
1900	$20,500	1911	$51,824
1901	40,000	1912	23,050
1902	162,100	1913	13,740
1903	110,500	1914	3,970
1904	136,000	1915	3,565
1905	148,500	1916	4,752
1906	497,090	1917	3,049
1907	232,642	1918	650
1908	208,950	1919	5,425
1909	193,700		
1910	237,475	Total	$2,097,482

GRAPHITE.

Bibliography: State Mineralogist Reports XIII, XIV, XV. Bulletin 67. U. S. G. S., Min. Res., 1914, Pt. II.

Graphite has been produced from time to time in the state, coming principally from Sonoma and Los Angeles counties. It is difficult for these deposits, which are not hight grade, to compete with foreign supplies which go on the market almost directly as they come from the

deposit. Low-grade ores are concentrated with considerable difficulty and the electric process of manufacturing artificial graphite from coal has been perfected to such a degree that only deposits of natural graphite of a superior quality can be exploited with any certainty of success.

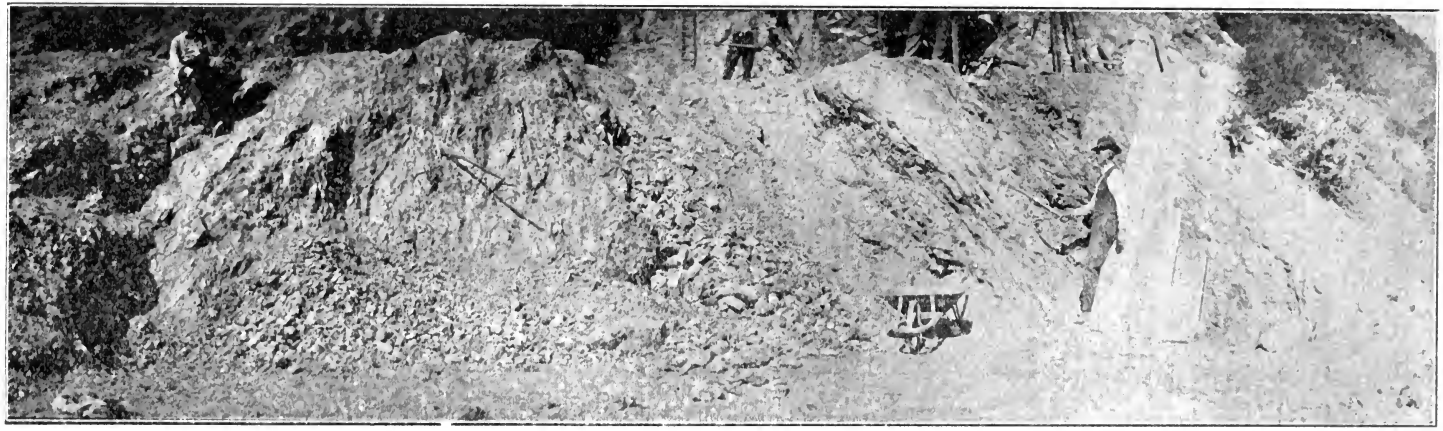
According to a recent report by the U. S. Geological Survey, "at present prices, miners in this country who are working disseminated flake deposits must depend on their No. 1 and 2 flake for their profit. Graphite dust is merely a by-product and is salable only at a low price. Improved methods of graphite milling, adopted * * * promise to increase largely the production of flake of better grade."

On account of its infusibility and resistance to the action of molten metals, graphite is very valuable. It is also largely used in the manufacture of electrical appliances, of 'lead' pencils, as a lubricant, as stove polish, paints, and in many other ways. Amorphous graphite, commonly carrying many impurities, brings a much lower price. For some purposes, such as foundry facings, etc., the low-grade material is satisfactory. The price increases with the grade of the material until the best quality crystalline variety ordinarily ranges as high as $200 per ton. Because of the increased demand during the war period for brass and crucible steel, the requirement for graphite crucibles grew rapidly, thus boosting the price of flake graphite to above $400 per ton for Ceylon lumps. The coarser flakes are necessary for crucibles, as they help to bind the clay together in addition to their refractory service. Since the close of hostilities in Europe, prices have declined to nearly the pre-war level; and imports are being resumed from Ceylon, Canada and Madagascar.

Among the newer uses for graphite is the prevention of formation of scale in boilers. The action is a mechanical one. Being soft and slippery, the graphite prevents the particles of scale from adhering to one another or to the boiler and they are thus easily removed.

Occurrence of graphite has been reported at various times from Calaveras, Fresno, Imperial, Los Angeles, Mendocino, San Bernardino, San Diego, Siskiyou, Sonoma and Tuolumne counties.

During 1919 a greatly increased production was reported from Los Angeles County. It was concentrated from a disseminated ore, and was used for paint, foundry facing, and lubricants. As there was



Open-cut graphite on outcrop 50 feet wide. California Graphite Company deposit, San Francisquito Cañon, Los Angeles County. Photo by courtesy of the Company.

but a single operator, the figures are concealed under the 'Unapportioned' item. The production, by years, has been as follows:

Year	Pounds	Value
1901	128,000	$4,480
1902	84,000	1,680
1903		
1913	2,500	25
1914		
1915		
1916	29,190	2,335
1917	*	*
1918	*	*
1919	*	*
Totals	243,690	$8,520

*Concealed under 'Unapportioned,' on account of a single producer.

GYPSUM.

Bibliography: Reports XIV, XV. Bulletins 38, 67.

Gypsum is widely distributed throughout the state, and is produced to a considerable extent, to supply the fertilizer manufacturers and also those of plaster and cement.

The action of gypsum as a fertilizer is indirect[1]; it is not a food for plants, but it is supposed to act on the double silicate of magnesia and potash in the soil, freeing the magnesia and potash, so that they become available as plant food. Its use is believed to be beneficial only if these elements are present in the soil, and its application to some soils would therefore be of no advantage.

Some authorities hold that land plaster tends to make nonporous clay soils more pervious to water and to make sandy soils less pervious. Ground gypsum has an affinity for water and will draw moisture from the atmosphere, so it keeps moisture in the soil and is of value to the farmer who is starting grain and grass crops, as it holds moisture where the roots of the small plants most need it. The use of ground gypsum or land plaster in a dry, hot season may draw enough moisture from the atmosphere to save a crop from damage by drought. Land plaster is employed to neutralize the black alkali that forms in many of the soils of arid regions, as in parts of California, Nevada and Utah.

Land plaster may be applied to the soil by drilling, or scattered in the hill, or it may be sowed broadcast, in quantities ranging from 200 to 500 pounds to the acre.

[1]U. S. G. S. Press Bulletin No. 374, July, 1918, p. 4.

In the calcined form as plaster of Paris, gypsum plays a very important part in surgical work. It is also widely used in building operations, as a hard-wall plaster, as plaster board, etc.

During 1919, producers in Riverside and San Bernardino counties took out a total of 19,813 tons, valued at $50,579, being an increase from the 19,695 tons, valued at $37,176 in 1918.

Total annual production of gypsum in California since such records have been compiled by this Bureau is as follows:

Year	Tons	Value	Year	Tons	Value
1887	2,700	$27,000	1905	12,859	$54,500
1888	2,500	25,000	1906	21,000	69,000
1889	3,000	30,000	1907	8,900	57,700
1890	3,000	30,000	1908	34,600	155,400
1891	2,000	20,000	1909	30,700	138,176
1892	2,000	20,000	1910	45,294	129,152
1893	1,620	14,280	1911	31,457	101,475
1894	2,446	24,584	1912	37,529	117,388
1895	5,158	51,014	1913	47,100	135,050
1896	1,310	12,580	1914	29,734	78,375
1897	2,200	19,250	1915	20,200	48,953
1898	3,100	23,600	1916	33,384	59,533
1899	3,663	14,950	1917	30,825	56,840
1900	2,522	10,088	1918	19,695	37,176
1901	3,875	38,750	1919	19,813	50,579
1902	10,200	53,500			
1903	6,914	46,441	Totals	489,639	$1,806,926
1904	8,350	56,592			

INFUSORIAL and DIATOMACEOUS EARTHS.

Bibliography: State Mineralogist Reports II, XII, XIII, XIV, XV. Bulletins 38, 67.

Infusorial and diatomaceous earths—sometimes called tripolite—are very light and extremely porous, chalk-like materials composed of pure silica (chalk, being calcareous) which have been laid down under water and consist of the remains of microscopical infusoria and diatoms. The former are animal remains, and the latter are from plants. The principal commercial use of this material is as an absorbent; and it is also employed in the manufacture of scouring soap and polishing powders, and in making some classes of refractory brick. It is a first-class non-conductor of heat, where high temperatures are employed, such as around steel and gas plants and power houses. In such cases, it is built in as an insulating layer in furnace walls. In Germany, under the name 'kieselguhr,' it was used as an absorbent for nitroglycerine in the early manufacture of dynamite.

As a nonconductor of heat it has been used alone or with other materials as a covering for boilers, steam pipes, and safes and in fireproof cements. It is used largely by paint manufacturers as a wood

filler. Boiled with shellac it is made into records for talking machines. It has been used for absorbing liquid manures so that they could be utilized as fertilizers, and as a source of silica in making water-glass as well as in the manufacture of cement, tile glazing, artificial stone, ultra-marine and other pigments of aniline and alizarine colors, paper filling, sealing wax, fireworks, hard-rubber objects, matches, and papier-maché, and for solidifying bromine.

The most important deposits in California thus far known are located in Monterey, Orange, San Luis Obispo, and Santa Barbara counties. The Santa Barbara material is diatomaceous and is of a superior quality. Infusorial earth is also found in Fresno, Kern, Los Angeles, Plumas, San Benito, San Bernardino, San Joaquin, Shasta, Sonoma, and Tehama counties.

During 1919, three quarries operating in Monterey and Santa Barbara counties, produced a total of 40,200 tons, valued at $217,800, which is a material increase over the 35,963 tons, valued at $189,459 in 1918.

The first recorded production of these materials in California occurred in 1889; total amount and value of output, to date, are as follows:

Year	Tons	Value	Year	Tons	Value
1889	39	$1,335	1906	2,430	$14,400
1890			1907	2,531	28,948
1891			1908	2,950	32,012
1892			1909	500	3,500
1893	50	2,000	1910	1,843	17,617
1894	51	2,040	1911	2,194	19,670
1895			1912	4,129	17,074
1896			1913	8,645	35,968
1897	5	200	1914	12,840	80,350
1898			1915	12,400	62,000
1899			1916	15,322	80,649
1900			1917	24,301	127,510
1901			1918	35,963	189,459
1902	422	2,532	1919	40,200	217,800
1903	2,703	16,015			
1904	6,950	112,282	Totals	179,468	$1,078,361
1905	3,000	15,000			

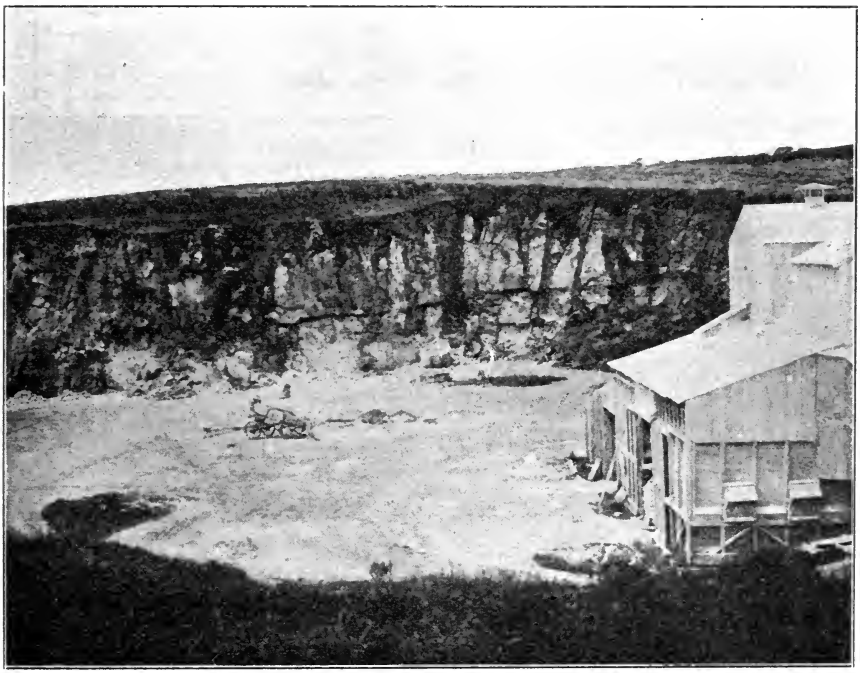
LIMESTONE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV, XV. Bulletin 38. Oregon Agr. College Extension Bulletin 305.

Limestone was produced in 11 counties during 1919, to the amount of 88,291 tons, valued at $248,145. The very considerable decrease from 208,566 tons, valued at $456,258 in 1918, is due in part to the shutdown of the Shasta County copper smelters, which use large tonnages of limestone as flux. There were also notable decreases in El

Dorado and Kern counties. This amount does not include the limestone used in the manufacture of cement nor of lime for building purposes, but accounts for that utilized as a smelter flux, for glass and sugar making, and in other chemical and manufacturing processes (including fertilizers, roofiing preparations, whiting for paint, terrazzo, chicken grit, and for CO_2).

In agriculture, the chief reason for the use of lime is now recognized to be that of correcting soil acidity. Lime is stated to be especially



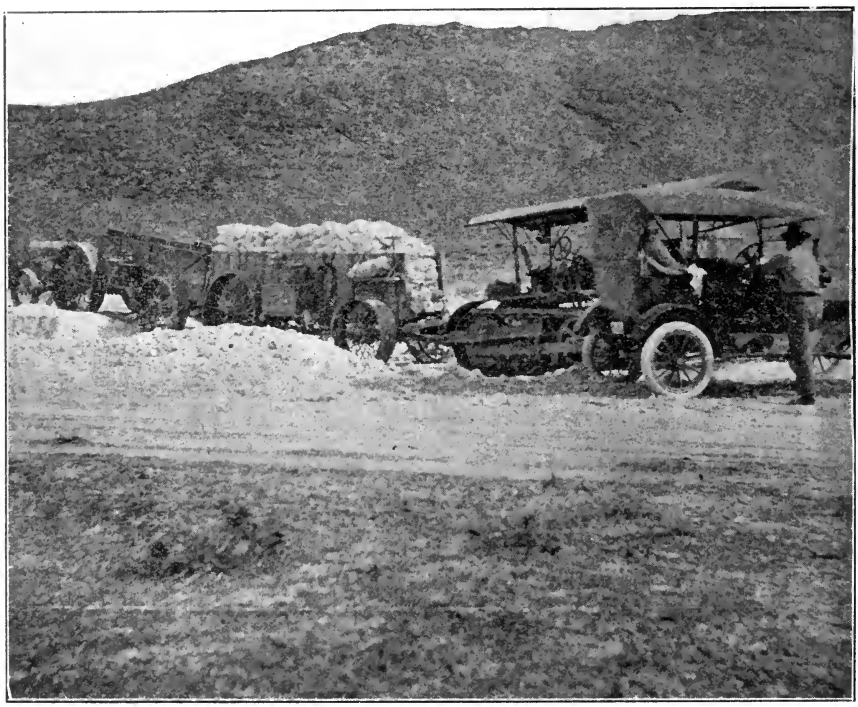
Limestone quarry with crushing and screening plant of W. A. Caplatzi, at Santa Cruz, Santa Cruz County.

necessary for the proper development of the bacteria in the nodules on the roots of the legumes such as the clovers and alfalfa. It will also combine with some of the plant food materials already in the soil to make them more readily available, and will supply any lack of calcium as a plant food that may exist in the soil. To some extent, certain forms of lime will make heavy soils more friable, thus aiding aeration, cultivation and drainage. It may be applied, ground, in either the burned or unburned form, or as hydrated lime.

Distribution of the 1919 output is as follows:

County	Tons	Value
El Dorado	41,025	$112,423
Inyo	2,360	12,000
Santa Cruz	5,527	12,690
Tulare	10,347	46,388
Kern, Plumas, Santa Barbara, Santa Clara,[1] Shasta, Siskiyou, Tuolumne*	29,032	64,644
Totals	88,291	$248,145

[1]Clam-shell marl used for fertilizer.
*Combined to conceal output of a single operator in each.



Hauling 'whiting' (calcium carbonate) from White Boy Claim of Seipp and Merwin, on edge of Death Valley, Inyo County, California. Photo by S. R. Merwin.

In the early reports of this Bureau values for lime and limestone were not segregated. The following tabulation shows the total com-

bined value of such material since records for the state were first compiled, in 1887, to date:

Year	Value	Year	Value
1887	$368,750	1905	$878,647
1888	381,750	1906	925,887
1889	416,780	1907	1,162,417
1890	350,000	1908	676,507
1891	300,000	1909	997,745
1892	300,000	1910	1,058,891
1893	301,276	1911	843,778
1894	337,975	1912	1,034,688
1895	457,784	1913	803,002
1896	332,617	1914	896,376
1897	291,465	1915	442,592
1898	278,558	1916	608,208
1899	343,760	1917	667,776
1900	315,231	1918	917,573
1901	434,133	1919	800,188
1902	460,140		
1903	582,268	Total	$19,625,718
1904	658,956		

LITHIA.

Bibliography: State Mineralogist Reports II, IV, XIV. Bulletins 38, 67.

Lithia mica, lepidolite (a silicate of lithium et al.) utilized in the manufacture of artificial mineral water, fireworks, glass, etc., has been mined in San Diego County since 1899, except between 1905 and 1915. Some amblygonite, a lithium phosphate, has also been obtained from pockets associated with the gem tourmalines. In 1919, the yield of lepidolite was 800 tons, valued at $14,400, and was utilized in glass manufacture.

Lithia mica total production in the state has been as follows:

Year	Tons	Value	Year	Tons	Value
1899	124	$4,600	1915	91	$1,365
1900	440	11,000	1916	71	1,065
1901	1,100	27,500	1917	880	8,800
1902	822	31,880	1918	4,111	73,998
1903	700	27,300	1919	800	14,400
1904	641	25,000			
1905	25	276	Totals	5,805	$227,184
1906					

MICA.

Bibliography: State Mineralogist Reports II, IV. Bulletins 38, 67.

No commercial production of mica has recently been reported in California. Production in previous years has been as follows:

Year	Tons	Value
1902	50	$2,500
1903	50	3,800
1904	50	3,000
Totals	150	$9,300

[1]"The different uses to which mica is put depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades and in insulation.

"Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo-electric machinery, electric-light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves and for making lamp chimneys and lamp shades. It is also used in spectacles, automobile shields, phonograph diaphragms, in windows where glass would be broken, and in lantern transparencies.

"Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerin in the manufacture of 'mica powder,' in tempering steel; to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings; and as a filler for various products. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts is indicated in a recent Geological Survey report.[2]

"It is understood that sheet mica has come to be of importance as a war mineral through its use abroad as windows in masks worn for defense against asphyxiating gases, and for other uses where a transparent, noninflammable, nonshattering material is necessary, as in automobile goggles and in windows for armored cars."

MINERAL PAINT.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38.

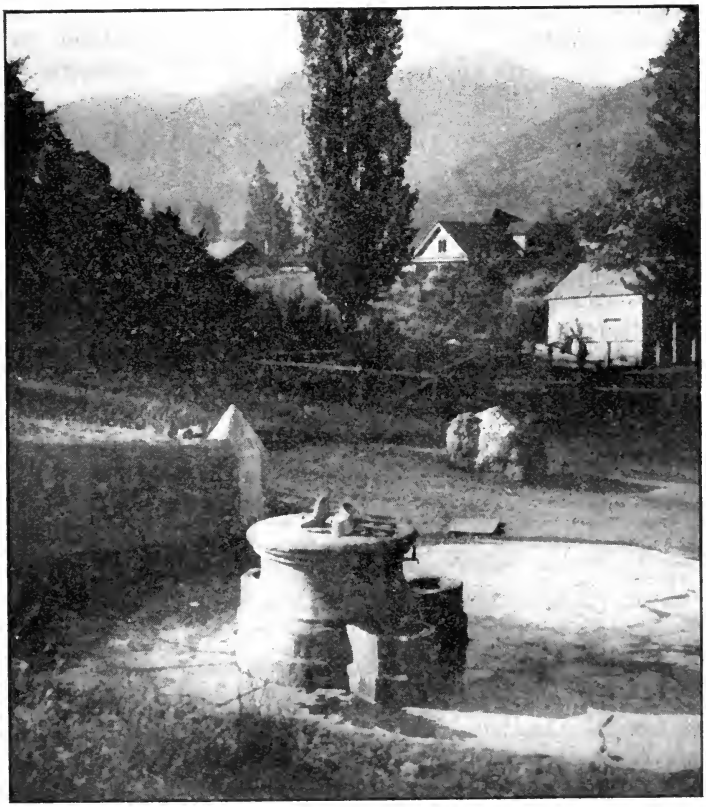
Mineral paint was produced in California in 1919 from Colusa and Stanislaus counties, amounting to 1,780 tons, valued at $17,055. This is an increase from the tonnage and value of 1918. There were four producers in Stanislaus County and one in Colusa. The material from Colusa is siliceous hematite, and that from Stanislaus, yellow ochre. The Calaveras and Stanislaus yellow ochre is the equal of any of the imported ochres.

Besides the above-named counties, deposits of mineral paint are located in the following: Kern, Kings, Lake, Los Angeles, Nevada, Riverside, and Sonoma.

[1]Schaller, W. T., Mica in 1916: U. S. Geol. Surv., Min. Res. of U. S., 1916, p. 304, 1917.
[2]Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite by George Steiger: U. S. Geol. Survey Bull. 620, pp. 227–235, 1916.

The first recorded production of this material in the state was in the year 1890. The output showing annual amount and value, since that time, is given herewith:

Year	Tons	Value	Year	Tons	Value
1890	40	$480	1906	250	$1,720
1891	22	880	1907	250	1,720
1892	25	750	1908	335	2,250
1893	590	26,795	1909	305	2,325
1894	610	14,140	1910	200	2,040
1895	750	8,425	1911	186	1,184
1896	395	5,540	1912	300	1,800
1897	578	8,165	1913	303	1,780
1898	653	9,698	1914	132	847
1899	1,704	20,294	1915	311	1,756
1900	529	3,993	1916	643	3,960
1901	325	875	1917	520	2,700
1902	589	1,533	1918	728	4,738
1903	2,370	3,720	1919	1,780	17,055
1904	270	1,985			
1905	754	4,025	Totals	16,447	$150,173



'Bartlett' spring, at Bartlett Springs, Lake County, California.

MINERAL WATER.

Bibliography: State Mineralogist Reports VI, XII, XIII, XIV, XV. U. S. G. S., Water Supply Paper 338.

A widespread production of mineral water is shown annually in California. These figures refer to mineral water actually bottled for sale, or for local consumption. Water from some of the springs having a special medicinal value brings a price many times higher than the average shown, while in some cases the water is used merely for drinking purposes and sells for a nominal figure. Health and pleasure resorts are located at many of the springs. The waters of some of the hot springs are not suitable for drinking, but are very efficacious for bathing. From a therapeutic standpoint, California is particularly rich in mineral springs. The counterparts of practically any of the world-famed spas of Europe or the eastern United States can be found here.

An interesting, recent development is the obtaining of 'geyser' wells at Calistoga, in Napa County, by drilling into the thermal-water strata underlying that part of the Napa Valley. There are at least four wells so erupting. They spout in true geyser fashion, and their periods vary from 10 minutes to 2 hours, each following its own schedule rather closely.

It is hoped that the State Mining Bureau will be able in the near future to make some systematic tests as to the radio-activity of the thermal waters of the hot springs of California. Some preliminary qualitative tests have been made by the writer at The Geysers in Sonoma County, and positive reactions obtained; also, radio-activity has been proven at Arrowhead Hot Springs in San Bernardino County, by Prof. Gilbert E. Bailey of the University of Southern California.

Commercial production by counties, for 1919, was:

County	Gallons	Value
Butte	6,532	$2,388
Calaveras	4,384	1,034
Lake	62,839	17,471
Los Angeles	125,400	8,787
Napa	76,860	60,395
San Bernardino	800,060	32,006
Santa Barbara	82,147	81,041
Siskiyou	451,500	90,375
Sonoma	96,860	22,820
Contra Costa, Humboldt, Marin, Riverside, San Benito, San Diego, Santa Clara, Shasta, Solano, Trinity*	527,320	23,800
Totals	2,233,842	$340,117

*Combined to conceal output of a single operator in each.

Amount and value of mineral water produced in California since 1887 are given herewith:

Year	Gallons	Value	Year	Gallons	Value
1887	618,162	$144,368	1905	2,194,150	$538,700
1888	1,112,202	252,990	1906	1,585,690	478,186
1889	808,625	252,241	1907	2,924,269	544,016
1890	258,722	89,786	1908	2,789,715	560,507
1891	334,553	139,959	1909	2,449,834	465,488
1892	331,875	162,019	1910	2,335,259	522,009
1893	383,179	90,667	1911	2,637,669	590,654
1894	402,275	184,481	1912	2,497,794	529,384
1895	701,397	291,500	1913	2,350,792	599,748
1896	808,843	337,434	1914	2,443,572	476,169
1897	1,508,192	345,863	1915	2,274,267	467,738
1898	1,429,809	213,817	1916	2,273,817	410,112
1899	1,338,537	406,691	1917	1,942,020	340,566
1900	2,456,115	268,607	1918	1,808,791	375,650
1901	1,555,328	559,057	1919	2,233,842	340,117
1902	1,701,142	612,477			
1903	2,056,340	558,201	Totals	54,977,097	$12,646,148
1904	2,430,320	496,946			

PHOSPHATES.

Bibliography: Bulletin 67.

No commercial production of phosphates has been recorded from California, though occasional pockets of the lithia phosphate, amblygonite, Li (AlF) PO_4, have been found associated with the gem tourmaline deposits in San Diego County. Such production has been classified under lithia.

PUMICE and VOLCANIC ASH.

Bibliography: State Mineralogist Reports XII, XIV, XV. Bulletin 38 (see 'Tufa').

The production of pumice and volcanic ash for the year 1919 amounted to 2,388 tons, valued at $43,657, and came from Imperial, Inyo and Siskiyou counties. This is an increase over the 2,114 tons, valued at $28,669, in 1918. The material from Imperial and Siskiyou counties is the vesicular, block pumice, these being practically the only localities in the United States producing this class of rock at the present time; and is stated to have found a ready market. The Lipari Islands, Italy, have in the past been the principal source of supply of block pumice. This form is used largely for abrasive purposes; and is also being utilized in fire-brick, and as an insulating filler in the walls of refrigerators and cold-storage plants. It is also being tried in concrete. There are other known deposits of pumice in California, in Inyo, Madera, and Mono counties. The material from Humboldt,

Inyo and Madera counties is the fine-grained, volcanic ash, or tuff variety. It is employed in making scouring soaps and polishing powders.

Commercial production of pumice in California was first reported to the State Mining Bureau in 1909, then not again until 1912, since which year there has been a small annual output, as indicated by the following table:

Year	Tons	Value	Year	Tons	Value
1909	50	$500	1916	1,246	$18,092
1910	-------	-------	1917	525	5,295
1911	-------	-------	1918	2,114	28,669
1912	100	2,500	1919	2,388	43,657
1913	3,590	4,500			
1914	50	1,000	Totals	10,443	$110,613
1915	380	6,400			

Brand & Stevens' pumice, Imperial County. Thirty-ton dump of pumice, selected for grinding, awaiting shipment. Shows average size of material obtained. Photo by Emile Huguenin.

PYRITE.

Bibliography: Bulletin 38. Min. & Sci. Press, Vol. 114, pp. 825, 840.

Pyrite is mined for use in the manufacture of sulphuric acid, which in turn is used in large quantities in the preparation of explosives. Experiments are being made as to the effect of sulphur, sulphuric acid, and SO_2 in the correction and fertilization of alkali soils. Two properties each in Alameda and Shasta counties reported a total production

in 1919 of 147,024 tons, valued at $540,300, which is an increase over 1918. The material shipped carried 45% to 48% S.

This does not include the large quantities of pyrite which are otherwise treated for their valuable metal contents. Some sulphuric acid is annually made as a by-product in the course of roasting certain tonnages of Mother Lode auriferous concentrates for their precious-metal values. California has, available, supplies of sulphide ores suitable for the manufacture of sulphuric acid far in excess of the local requirements; but the excess acid if made here is not of sufficient value per ton to pay the freight rates to Eastern markets. One of our large copper smelters here could, alone, flood the market with sulphuric acid from its copper ores roasted.

The total recorded pyrite production in California to date is as follows:

Year	Tons	Value	Year	Tons	Value
1898	6,000	$30,000	1910	42,621	$179,862
1899	5,400	28,620	1911	54,225	182,954
1900	3,642	21,133	1912	69,872	203,470
1901	4,578	18,429	1913	79,000	218,537
1902	17,525	60,306	1914	79,267	230,058
1903	24,311	94,000	1915	92,462	293,148
1904	15,043	62,992	1916	120,525	372,969
1905	15,503	63,958	1917	111,325	323,704
1906	46,689	145,895	1918	128,329	425,012
1907	82,270	251,774	1919	147,024	540,300
1908	107,081	610,335			
1909	457,867	1,389,802	Totals	1,710,559	$5,747,308

SILICA—SAND and QUARTZ.

Bibliography: State Mineralogist Reports IX, XIV. Bulletins 38, 67.

We combine these materials, because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manufacture, also serves as an abrasive. Both varieties are also utilized to some extent in fire-brick manufacture.

A portion of the tonnage of vein quartz in California in 1916 and 1917 was employed in the preparation of ferro-silicon by the electric furnace. Some also is utilized as a foundry flux, and for steel casting moulds. In 1918–1919, a portion of the silica sold (both sand and quartz) was used in glazes for porcelain, pottery and tile; and some of the sand for the preparation of sodium silicate.

The production of silica in 1919 amounted to 18,659 tons, valued at $101,600, from eleven properties in Amador, El Dorado, Monterey, Riverside and San Diego counties:

County	Tons	Value
Amador	8,440	$67,366
Riverside	3,034	15,112
El Dorado, Monterey, San Diego*	7,185	19,122
Totals	18,659	$101,600

*Combined to conceal output of a single operator in each.

Of the above total 3,891 tons were of vein and boulder quartz, and 14,768 tons, sand.

Practically all the glass sand produced in California occurs as such and needs no grinding. There are various deposits of quartz which could be utilized for glass making, but to date there has been only a small commercial production of this class of material.

Silica sand has been produced in the following counties of the state: Alameda, Amador, El Dorado, Los Angeles, Monterey, Orange, Placer, Riverside, San Joaquin, and Tulare. The chief producing centers have been Amador, Monterey, and Los Angeles counties. The industry is of limited importance, so far, because of the fact that much of the available material is not of a grade which will produce first-class colorless glass; for such, it must be essentially iron-free. Even a fractional per cent of iron imparts a green color to the glass.

Total silica production in California since the inception of the industry, in 1899, is shown below, being mainly sand:

Year	Tons	Value	Year	Tons	Value
1899	3,000	$3,500	1911	8,620	$8,672
1900	2,200	2,200	1912	13,075	15,404
1901	5,000	16,250	1913	18,618	21,899
1902	4,500	12,225	1914	28,538	22,688
1903	7,725	7,525	1915	28,904	34,322
1904	10,004	12,276	1916	20,880	48,908
1905	9,257	8,121	1917	19,376	41,166
1906	9,750	13,375	1918	23,257	88,930
1907	11,065	8,178	1919	18,659	101,600
1908	9,255	22,045			
1909	12,259	25,517	Totals	283,166	$533,066
1910	19,224	18,265			

SOAPSTONE and TALC.

Bibliography: State Mineralogist Reports XII, XIV, XV. Bulletins 38, 67.

Talc—also called soapstone or steatite—occurs widely distributed throughout California. It is found as a hydration product in the alteration of magnesian silicates, and is often associated with serpentine and actinolite. A few deposits have been proven of especial value to date, and there is an undoubted future for this branch of the mineral industry in the state. Deposits of high-grade white talc, the equal of the imported Italian article, are now being developed in Inyo and San Bernardino counties. It is used in making paper, rubber, toilet articles, soap, rice polishing, lubricants, tiling, etc., and for such is ordinarily ground to about 200 mesh before marketing. In this condition it brings $15 per ton and upwards, depending on quality. Commercially, the higher grades are called talc, and the lower, soapstone. Soapstone blocks are used in fireless cookers, electrical switchboards, laboratory table tops and laundry tubs; and the crushed material is used in roofing papers.

There was a total output in 1919 of 8,764 tons, valued at $115,091 from two producers each in Amador, El Dorado, and San Bernardino, and one in Inyo. This is a decrease in tonnage, but an increase in value over the 1918 output.

County	Tons	Value
El Dorado	1,600	$13,950
San Bernardino	3,601	19,845
Amador and Inyo*	3,563	81,296
Totals	8,764	$115,091

*Combined to conceal output of a single operator in Inyo County.

Production has been intermittent in the state since 1893, as shown in the following table:

Year	Tons	Value	Year	Tons	Value
1893	400	$17,750	1908	3	$48
1894			1909	33	280
1895	25	375	1910	740	7,260
1896			1911		
1897			1912	1,750	7,350
1898			1913	1,350	6,150
1899			1914	1,000	4,500
1900			1915	1,663	14,750
1901	10	119	1916	1,703	9,831
1902	14	288	1917	5,267	45,279
1903	219	10,124	1918	11,760	85,534
1904	228	2,315	1919	8,764	115,091
1905	300	3,000			
1906			Totals	35,229	$330,044
1907					

STRONTIUM.

Bibliography: Bulletin 67. U. S. G. S., Bull. 540; 660-I.

There was no production of strontium minerals in California in 1919, though in 1918 both celestite ($SrSO_4$), and the carbonate, strontianite ($SrCO_3$) were shipped. The first recorded commercial output of strontium minerals in California was in 1916. The occurrence of the carbonate is particularly interesting and valuable, as it appears to be the first considerable deposit of commercial importance so far opened up in the United States. Shipments reported as averaging 80% $SrCO_3$ have been made. The deposit is associated with deposits of barite.

In addition to the Imperial County occurrence, noted in our 1916 bulletin, celestite is also found near Calico and Ludlow, and in the Avawatz Mountains in San Bernardino County, but as yet undeveloped. The above noted output was converted to the nitrate.

Production of strontium minerals in California, by years, has been as follows:

Year	Tons	Value
1916	57	$2,850
1917	3,050	37,000
1918	2,900	33,000
1919		
Totals	6,007	$72,850

It is estimated by the U. S. Geological Survey, that prior to 1914 about 2000 tons of strontium nitrate was used in the manufacture of flares, or Costen and Bengal lights and fireworks. The nitrate was imported from Germany, England and Sicily.

There is undoubtedly a good future for the strontium minerals in California, if the beet-sugar factories will take up their use, as has been done in Germany. Strontia is much more efficient and satisfactory in that process than lime, as it is stated to give an additional recovery of 6%-8% over lime. In Germany and Russia, about 100,000 tons of strontium hydroxide were used annually in the sugar industry.

Of the two minerals, strontianite is the more desirable, but scarcer. Celestite is more abundant, and can be sold at about $14–$18 per ton at the Atlantic seaboard. The carbonate during 1918 brought from $40–$50 per ton, crude, depending on quality. Celestite is found with limestones and sandstones and is sometimes associated with gypsum. Strontianite is also found with limestone, but associated with barite and calcite.

SULPHUR.

Bibliography: State Mineralogist Reports IV, XIII, XIV. Bulletins 38, 67.

There has not been, for many years, any commercial output of native sulphur in California, although this mineral has been found to some extent in Colusa, Imperial, Inyo, Kern, Lake, Mariposa, San Bernardino, Sonoma, Tehama, and Ventura counties. Operations were begun late in 1917, on a property in Inyo County, and some material stated to assay 40% sulphur was mined. Difficulties were encountered in refining it, so that only a small production was made, but none shipped.

At the Elgin mine, near Wilbur Springs, in Colusa County, a small tonnage of sulphur was prepared toward the close of 1918, but not shipped. The orebody is stated to assay 52.6% S. over a width of 22 feet. Two retorts, steam-heated, were installed, with a capacity of 4500 pounds of ore, each, per charge. There is a large body of material, in a zone at least 75 feet wide, impregnated with native sulphur crystals, which can be cheaply mined, if certain mechanical difficulties of melting and cleaning can be economically overcome.

Sulphur was produced at the famous Sulphur Bank mine, in Lake County, during the years 1865–1868 (inc.) totaling 941 tons, valued at $53,500; following which the property became more valuable for its quicksilver. The Elgin mine, noted above, is a similar occurrence.

About 37,000 tons of sulphur per year are imported to the United States from Japan, most of it coming in through the port of San Francisco. The principal sources in the United States are the stratified deposits in Louisiana and Texas, extraction being accomplished by a unique system of wells with steam pipes. It is stated that the three large companies operating there are capable of producing more than 1,000,000 tons annually in excess of our normal consumption in the United States, which averages about 600,000 tons.

Formerly considerable sulphur was imported from Italy, the Palermo district being the principal producer. The industry is under the control of the government, and exports are under license. According to a U. S. Consular Report:[1]

"Prices range from $55 to $57 for crude, to $73 to $85 for refined. As American sulphur is cheaper than Sicilian, it is believed that should freights become normal it will be possible to import American sulphur into Italy."

[1]Consular Report, Annual Series, No. 8c, Nov. 29, 1918, p. 8.

CHAPTER SIX.

SALINES.

Under this heading are included borax, common salt, soda, potash, and other alkaline salts. The first two have been produced in a number of localities in California, more or less regularly since the early sixties, although the State Mining Bureau kept no annual records of output previous to 1887. Except for a single year's absence, soda has had a continuous production since 1894. Potash, and magnesium chloride and sulphate have only recently been added to the commercial list, while the nitrates are still prospective.

Our main resources of salines are the lake beds of the desert regions of Imperial, Inyo, Kern, Los Angeles, San Bernardino, San Luis Obispo, and Siskiyou counties, and the waters of the Pacific Ocean.

The following tabulation shows amount and value of the saline minerals produced in California during the years 1918 and 1919, with increase or decrease in value for 1919, as compared with the previous year:

Substance	1918		1919		Increase + Decrease— Value
	Tons	Value	Tons	Value	
Borax	88,772	$1,867,908	66,791	$1,717,192	$150,716—
Magnesium salts	1,008	29,955	1,616	82,457	52,502+
Potash	49,381	6,808,976	28,118	2,415,963	4,393,013—
Salt	212,076	806,328	233,994	896,963	90,635+
Soda	20,447	855,423	21,294	721,958	133,465—
Total value		$10,368,590		$5,834,533	
Net decrease					$4,534,057—

BORAX.

Bibliography: State Mineralogist Reports III, X, XII, XIII, XIV, XV. Bulletins 24, 67.

Borax was first discovered in California in the waters of Tuscan Springs in Tehama County, January 8, 1856. Borax Lake, in Lake County, was discovered in September of the same year by Dr. John A. Veatch. This deposit was worked in 1864–1868, inclusive, and during that time produced 1,181,365 pounds of refined borax. This was the first commercial output of this salt in the United States, and California is still today the only American producer of borax.

Production from the dry lake or 'playa' deposits of Inyo and San Bernardino counties began in 1873; but it was not until 1887 that the borax industry was revolutionized by the discovery of the colemanite

beds at Calico in San Bernardino County. These have since been worked out, and the present output comes from similar beds in Inyo and Los Angeles counties. The colemanite deposits of Ventura County are at present unworked, owing to lack of transportation facilities.

During 1919, there was reported a total output of 66,791 tons, valued at $1,717,192, compared with 88,772 tons, valued at $1,867,908 in 1918. A portion of the 1919 production was made from the brine of Searles Lake in San Bernardino County.

Value of the state's borax output since 1887 is shown in the following table:

Year	Value	Year	Value
1887	$116,689	1905	$1,019,158
1888	196,636	1906	1,182,410
1889	145,473	1907	1,200,913
1890	480,152	1908	1,117,000
1891	640,000	1909	1,163,960
1892	838,787	1910	1,177,960
1893	593,292	1911	1,456,672
1894	807,807	1912	1,122,713
1895	595,900	1913	1,491,530
1896	675,400	1914	1,483,500
1897	1,080,000	1915	1,663,521
1898	1,153,000	1916	2,409,375
1899	1,139,882	1917	2,561,958
1900	1,013,251	1918	1,867,908
1901	982,380	1919	1,717,192
1902	2,234,994		
1903	661,400	Total	$36,689,623
1904	698,810		

MAGNESIUM SALTS.

Magnesium chloride is an important item in certain chemical uses, and in the preparation of Sorel cement in laying magnesite floors. Previous to 1915, Germany was the principal source of this chloride, which source has since, of course, been cut off. For this reason experiments have been made to prepare it by acid solution from magnesite, which is so abundant in California. Some of the salt companies began its commercial preparation in 1916, from the residual bitterns obtained during the evaporation of sea water for its sodium chloride.

In addition to the chloride, some magnesium sulphate, or 'technical epsom salts,' was also made at three of the plants: Oliver Chemical Company in Alameda County, Whitney Chemical Company in San Mateo County, and the Marine Chemical Company at Long Beach, Los Angeles County. In 1919, the Merle Magnesia Company at Redwood City, San Mateo County, produced magnesium carbonate. The chloride sold for $25 to $35 per ton, and the sulphate at $50 to $65 per ton.

The 1919 output of chloride, sulphate, and carbonate totaled 1616 tons, valued at $82,457, from Alameda, Los Angeles and San Mateo counties, compared with 1008 tons and $29,955 in 1918. The chloride was utilized in Sorel cement for flooring and stucco; the sulphate, for tannery and medical purposes; and the carbonate in the manufacture of '85% magnesia pipe and boiler covering' mixed with asbestos.

Bitterns made at plants on San Francisco Bay carry 23 to 86 parts of magnesium per thousand, or 2.3% to 8.6% magnesium.[1]

Metallic magnesium is prepared electrolytically, utilizing generally an electrolyte of magnesium chloride and an alkaline chloride. Its commonest known use is in the powdered form for flash lights in photography. During the war, magnesium was put in shrapnel shells, that observers and gunners might know exactly where the shells were bursting. By day the burning magnesium gives a dense pure-white cloud of magnesium oxide, and at night a dazzling white light. Larger quantities were used in aerial bombs and rockets for lighting up the country at night. Magnesium has as yet found but a limited direct use as a metal. Magnalium, an alloy of aluminum containing about 2% of magnesium and small percentages of other metals, is stated to be used in automobiles and aeroplanes. The possibilities for further important developments in this direction are promising.

NITRATES.

Bibliography: Report XV. Bulletin 24. U. S. G. S., Press Bulletin No. 373, July, 1918.

Nitrates of sodium, potassium and calcium have been found in various places in the desert regions of the state, but no deposit of commercial value has been developed as yet. It is hoped that a closer search may some day be rewarded by workable discoveries. At present the principal commercial source of nitrates is the Chilean saltpeter (sodium nitrate) deposits in South America.

The fixation of atmospheric nitrogen electrically has been accomplished successfully in Germany and Scandinavia. The possibilities of cheap hydro-electric power in California make the subject one of intense interest to us, as we have also the natural raw materials and chemicals to go with the power. Sodium and potassium cyanides can be made by fixation of atmospheric nitrogen electrically.

[1]U. S. Dept. Agr. Bur. Soils, Bull. 94, p. 63, 1913.

POTASH.

Bibliography: Report XV. Bulletin 24. U. S. G. S., Min. Res. 1913, 1914, 1915. Senate Doc. No. 190, 62d Congress, 2d Session. Mining & Sci. Press, Vol. 112, p. 155; Vol. 114, p. 789.

Potash production began commercially in California in 1914, with a small yield from kelp. Considerable money has been spent incident to developing deposits of potash-bearing residues and brines in the old lake beds of the desert regions, and production there is now on a commercial basis at two plants on Searles Lake. A third plant is under construction. The imports of potash salts and fertilizers from Germany previous to the European war had an annual value of several millions of dollars, and their cessation made a domestic production imperative.

The normal pre-war price of $35 to $40 per ton for high-grade agricultural salts has been succeeded by figures of several times those amounts, so that in April, 1916, the chloride was nominally quoted, at $425 per ton and the sulphate from $350 to $400 per ton. The selling price in 1919 at point of shipment for potash materials ranged from $2.30 to $3.30 per unit, corresponding to $230 to $330 per ton of 100% K_2O.

During 1919, a total of 28,118 tons of potash-bearing materials of all grades was produced in California, valued at $2,415,963. This is approximately only one-third of the value of the 1918 output.

The 1919 product included refined potassium chloride and kelp ash; refined sulphate from some of the cement mills; concentrated salts from the brine of Searles Lake; also potash char from molasses distillery waste and Steffens waste water in beet-sugar manufacture. An important tonnage of potash char was produced at one plant operating on Hawaiian molasses, but which is not included herein, not being of California origin.

Small tonnages of refined chloride were also made from bitterns at two of the salt plants on San Francisco Bay. No yield from kelp was made in 1919 in Los Angeles County.

The bulk of this output was utilized in fertilizer preparations; but the product of at least one of the kelp plants was further refined or converted to the form of the nitrate for explosives manufacture.

Other uses for potash salts besides those noted above, are in the manufacture of the best liquid soap and some higher-grade cake soaps, of some finer grades of glass, and in matches. The chemical requirements include tanning, dyeing, metallurgy, electroplating, photography, and medicine.

The large plant of the America Trona Corporation at Trona, on Searles Lake, San Bernardino County, began commercial operation in

September, 1916, and is shipping crude chloride of potash to Eastern fertilizer works. These crude salts carry the equivalent of from 20% to 38% K_2O. A second plant at Searles Lake, built by the Solvay Process Company, began commercial operation in 1917. Their product is a 65% KCl. A third plant is under construction by the West End Mining Company.

In the cement mill of the Riverside Portland Cement Company, the fine dust from ball and tube mills is collected by a Cottrell electrical fume precipitator, the material showing an approximately 11% potash content. Sulphate is prepared from this. Other cement plants, in San Bernardino and Santa Cruz counties, commenced recovery of potash in 1918.

The following tabulation shows the distribution of the 1919 output of potash in California.

County	Product	Equivalent per cent K_2O	Tons	Value
San Bernardino	Chloride and sulphate	35–75	21,171	$1,670,919
Santa Barbara	Chloride and kelp ash	[1]44	298	30,128
Alameda, Orange, Riverside, San Diego, San Mateo, Santa Clara, Santa Cruz.*	Chloride, sulphate, molasses distillery slops char, Steffens water char	32–52	6,649	714,916
Totals			28,118	$2,415,963

[1]Average.
*Combined to conceal output of a single operator in each.

The annual amounts and values of these potash materials since their beginning in California in 1914, are shown by the following table:

Year	Tons	Value
1914	10	$460
1915	1,076	19,391
1916	17,908	663,605
1917	129,022	4,202,889
1918	49,381	6,808,976
1919	28,118	2,415,963
Totals	225,515	$14,111,284

SALT.

Bibliography: State Mineralogist Reports II, XII, XIII, XIV, XV. Bulletin 24.

Most of the salt produced in California is obtained by evaporating the waters of the Pacific Ocean, plants being located on the shores of San Francisco Bay, at Long Beach, and on San Diego Bay. Additional amounts are derived from lakes and lake beds in the desert regions of

the state. The salt production of San Bernardino County is derived from deposits of rock salt which are worked by means of quarrying and steam shovels. A small amount of valuable medicinal salts is occasionally obtained in Mono and Tehama counties, by evaporation from mineral springs.

Formerly a considerable proportion of the table salt consumed in California was shipped in from Eastern points; but, at present, Cali-

Salt Jeposit of Pacific Rock Salt Company, near Amboy, San Bernardino County. Showing bed of 8 feet of rock salt. Photo by W. B. Tucker.

fornia salt refineries supply not only our own needs but export a fair tonnage to other markets.

County	Tons	Value
Alameda	157,751	$552,178
Kern	17,000	81,000
San Diego	12,400	52,860
San Mateo	30,238	136,190
Imperial, Inyo, Los Angeles, Modoc, Monterey*	16,605	74,795
Totals	233,991	$896,963

*Combined to conceal output of a single operator in each.

The above returns show an increase both in tonnage and value, as compared to 1918. There were 12 plants operating in Alameda, two each in Kern and San Diego, three in San Mateo, and one in each of the other counties tabulated.

Amount and value of annual production of salt in California from 1887 is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	28,000	$112,000	1905	77,118	$141,925
1888	30,800	92,400	1906	101,650	213,228
1889	21,000	63,000	1907	88,063	310,967
1890	8,729	57,085	1908	121,764	281,469
1891	20,094	90,303	1909	155,680	414,708
1892	23,570	104,788	1910	174,920	395,417
1893	50,500	213,000	1911	173,332	324,255
1894	49,131	140,087	1912	185,721	383,370
1895	53,031	150,576	1913	204,407	462,681
1896	64,743	153,244	1914	223,806	583,553
1897	67,851	157,520	1915	169,028	368,737
1898	93,421	170,855	1916	186,148	455,695
1899	82,654	149,588	1917	227,825	584,373
1900	89,338	204,754	1918	212,076	806,328
1901	126,218	366,376	1919	233,994	896,963
1902	115,208	205,876			
1903	102,895	211,365	Totals	3,658,683	$9,453,786
1904	95,968	187,300			

SODA.

Bibliography: State Mineralogist Reports XII, XIII, XV. Bulletins 24, 67.

The production of the carbonates and sulphate of sodium, in California in 1919 included, soda ash from plants at Owens Lake, and the natural sulphate from the Carrizo Plains, San Luis Obispo County. The total tonnage was 21,294, valued at $721,958, the bulk of which came from the three plants in Inyo County.

These 'sodas' were used in the manufacture of glass, soap, and paper, as well as washing and baking soda, also in sugar refining.

The war stimulated the chemical industry in the United States to produce materials that were formerly imported and to supply them to foreign countries, as well as to devise new uses for chemical products, also to replace more expensive by less expensive chemicals. Sodium compounds have replaced potassium compounds, either wholly or in part, in glass and soap making, in photography, in match making, in tanning, and in the manufacture of cyanide for extracting gold and silver from their ores.

The total output, showing amount and value of these materials in California since the inception of the statistical records of the State Mining Bureau, is given in the table which follows:

Year	Tons	Value	Year	Tons	Value
1894	1,530	$20,000	1908	9,600	$14,400
1895	1,900	47,500	1909	7,712	11,593
1896	3,000	65,000	1910	8,125	11,862
1897	5,000	110,000	1911	9,023	52,887
1898	7,000	154,000	1912	7,200	37,094
1899	10,000	250,000	1913	1,861	24,936
1900	1,000	50,000	1914	6,522	115,396
1901	8,000	400,000	1915	5,799	83,485
1902	7,000	50,000	1916	10,593	264,825
1903	18,000	27,000	1917	24,505	928,578
1904	12,000	18,000	1918	20,447	855,423
1905	15,000	22,500	1919	21,294	721,958
1906	12,000	18,000			
1907			Totals	234,111	$4,354,437

CHAPTER SEVEN.

MINERAL PRODUCTION OF CALIFORNIA BY COUNTIES.

Introductory.

The State of California includes a total area of 158,360 square miles, of which 155,980 square miles are of land. The maximum width is 235 miles, the minimum, 148 miles; and the length from the northwest corner to the southeast corner is 775 miles. The state is divided into fifty-eight counties. Some mineral of commercial value exists in every county, and during 1919 active production was reported to the State Mining Bureau from fifty-seven counties of the fifty-eight. In the mountainous portions of the state are largely found the vein-forming minerals. In the desert regions of southeastern California ancient lake beds afford supplies of saline deposits. Underlying the interior valleys of the central and southern portion of the state are the large crude-oil reservoirs. Building stones and mineral earths of all descriptions are widely distributed throughout the length and breadth of the state. The 1920 census figures show a total population for California, of 3,437,709.

Of the first ten counties in point of total output for 1919, six (Kern, Orange, Los Angeles, Fresno, Santa Barbara, Ventura) owe their position mainly to petroleum. Kern, due to its oil, leads all the others by nearly three times the total of Orange, its nearest competitor. Shasta owes its rank to copper, gold, silver, zinc and pyrite, but dropped from sixth place in 1918 to eleventh in 1919 due to the decrease in copper output; San Bernardino, its place on account of potash, tungsten, cement, and copper; Inyo, mainly to borax, lead, tungsten and soda, but dropped from eighth to twelfth place in 1919; and Yuba, Amador, Nevada, mainly to gold. Twenty-two counties have each a total in excess of a million dollars, for 1919. Cement is an important item in six of these counties.

In point of variety and diversity, Riverside County led all the others in 1919 with a total of 19 different mineral products on its commercial list, followed by San Bernardino with 17, Inyo with 15, Shasta with 14, Los Angeles with 13, Kern and San Diego with 12.

The counties with their mineral resources, production for 1919, etc., are considered in detail in this chapter.

Value of California Mineral Production, by Counties, for 1919, Arranged in the Order of Their Importance.

County	Value
1. Kern	$67,153,361
2. Orange	27,848,727
3. Los Angeles	23,606,381
4. Fresno	21,643,898
5. Santa Barbara	7,594,917
6. San Bernardino	4,236,199
7. Yuba	3,943,537
8. Amador	3,439,842
9. Nevada	3,068,010
10. Ventura	3,017,074
11. Shasta	2,912,718
12. Inyo	2,674,835
13. Riverside	2,578,250
14. Sacramento	2,275,827
15. Santa Cruz	2,245,056
16. Plumas	2,183,750
17. Calaveras	1,886,608
18. Solano	1,672,084
19. Contra Costa	1,395,558
20. Alameda	1,364,685
21. San Benito	1,276,476
22. Santa Clara	1,048,571
23. Butte	803,829
24. Siskiyou	668,468
25. Stanislaus	590,326
26. Trinity	536,783
27. Tuolumne	459,396
28. San Joaquin	449,000
29. Placer	415,131
30. Mariposa	410,535
31. San Diego	343,230
32. Tulare	331,001
33. Sierra	292,950
34. Sonoma	286,038
35. Napa	275,303
36. San Mateo	241,671
37. Marin	228,974
38. San Luis Obispo	212,430
39. El Dorado	164,452
40. Monterey	148,504
41. Imperial	133,236
42. Madera	110,683
43. San Francisco	65,541
44. Glenn	59,637
45. Mono	52,682
46. Kings	51,283
47. Humboldt	43,667
48. Merced	40,350
49. Lake	39,375
50. Yolo	25,466
51. Mendocino	14,214
52. Tehama	9,000
53. Modoc	8,670
54. Colusa	7,300
55. Del Norte	6,871
56. Lassen	1,100
57. Alpine	100
58. Sutter	----------
Total	$196,473,560

ALAMEDA.

Area: 843 square miles.
Population: 344,177 (1920 census).

Alameda County, while in no sense one of the 'mining counties,' comes twentieth on the list with a value of mineral products for 1919 of $1,304,685, an increase from the 1918 total, which was $1,173,535. The mineral resources of this county include asbestos, brick, chromite, clay, coal, limestone, magnesite, manganese, pyrite, salt, soapstone, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Chromite	80 tons	$1,264
Brick and tile	----------	369,778
Clay (pottery)	5,011 tons	12,127
Pyrite	8,978 tons	42,902
Salt	157,751 tons	552,178
Stone, miscellaneous	----------	309,572
Other minerals*	----------	16,864
Total value	----------	$1,304,685

*Includes magnesium salts, manganese, and potash.

ALPINE.

Area: 776 square miles.
Population: 243 (1920 census).

Alpine has in the past shown a small production of gold and silver, but dropped out of the list of producing counties in 1914–1918. For 1919, crushed rock of $100 in value was reported.

This county lies just south of Lake Tahoe, in the high Sierra Nevada range of mountains. Transportation is by wagon or mule back, and facilities in general are lacking to promote development work of any kind.

The mineral resources of this section are varied and the country has not yet been thoroughly prospected. Occurrences of barium, copper, gold, gypsum, lead, limestone, pyrite, rose quartz, silver, tourmaline, and zinc have been noted here.

AMADOR.

Area: 601 square miles.
Population: 7,793 (1920 census).

The value of Amador County's mineral production decreased slightly from $3,452,640 in 1918 to $3,439,842, placing it number eight on the list of counties in the state as regards total value of mineral substances marketed. The drop was due to a decrease in gold output.

Although having an output consisting of 9 different minerals, the leading product, gold, makes up approximately 95% of the entire total. Amador led the state in gold production in 1915, but was slightly exceeded in 1917 by Nevada and Yuba counties, and by Yuba in 1918–1919.

The mineral resources of this county include asbestos, brick, chromite, clay, coal, copper, gold, lime, quartz crystals, glass-sand, sandstone, silver, soapstone, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Clay and clay products		$142,523
Gold		[1]3,200,000
Silica	8,440 tons	67,366
Silver		[1]20,000
Other minerals*		9,953
Total value		$3,439,842

*Includes coal, manganese, platinum, sandstone, and soapstone.
[1]Estimated.

BUTTE.

Area: 1,722 square miles.
Population: 30,030 (1920 census).
Location: North-central portion of state.

Butte, twenty-third county in California in regard to the value of its mineral output, reported a commercial production of nine mineral substances, having a total value of $803,829, as compared with $873,035 for 1918, the decrease being due to chromite. As will be noted in the following tabulation, gold is by far the most important item. Butte stands sixth among the gold-producing counties of the state. Among the mineral resources of this section are asbestos, barytes, chromite, gems, gold, limestone, marble, mineral water, platinum minerals, silver and miscellaneous stone.

Commercial value for 1919 was as follows:

Substance	Amount	Value
Gold		[1]$700,000
Mineral water	6,532 gals.	2,388
Platinum	33 oz.	5,071
Silver		[1]2,500
Stone, miscellaneous		92,765
Other minerals*		1,105
Total value		$803,829

*Includes gems and natural gas.
[1]Estimated.

CALAVERAS.

Area: 1,027 square miles.
Population: 6,183 (1920 census).
Location: East-central portion of state—Mother Lode district.

Calaveras County reported production of 8 different minerals, valued at $1,886,608 during the year 1919, as compared with the 1918 output at $2,794,452. Gold, copper and silver are the chief mineral substances produced. In regard to total value of mineral output Calaveras stands seventeenth among the counties of the state; it is fifth in gold, third in copper, fifth in silver, having been passed by Plumas in copper and silver output for 1918–1919, and by Kern in silver, 1919. The decrease, as compared with 1918, is due to gold and copper.

The principal mineral resources developed and undeveloped are: Asbestos, chromite, clay, copper, fuller's earth, gold, limestone, marble, mineral paint, mineral water, platinum minerals, pyrite, quartz crystals, silver, soapstone, and miscellaneous stone.

Commercial output for 1919 was as follows:

Substance	Amount	Value
Copper	2,049,330 lbs.	$381,175
Gold		[1]1,410,000
Lead	2,019 lbs.	107
Mineral water	4,384 gals.	1,034
Platinum	8 oz.	1,076
Silver		[1]84,500
Stone, miscellaneous		600
Other minerals		8,116
Total value		$1,886,608

[1]Estimated.

COLUSA.

Area: 1,140 square miles.
Population: 9,920 (1920 census).
Location: Sacramento Valley.

Colusa County lies largely in the basin of the Sacramento Valley. Its western border, however, rises into the foothills of the Coast Range of mountains, and it mineral resources—largely undeveloped—include coal, chromite, copper, gypsum, manganese, mineral water, pyrite, quicksilver, sandstone, miscellaneous stone, sulphur, and in some places traces of gold and silver.

The value of the 1919 production was $7,300 a decrease from the 1918 figures of $16,400, giving it fifty-fourth place.

Substance	Amount	Value
Stone, miscellaneous		$4,900
Other minerals		2,400
Total value		$7,300

CONTRA COSTA.

Area: 714 square miles.
Population: 53,889 (1920 census).

Contra Costa, like Alameda County, lies on the eastern shores of San Francisco Bay, and is not commonly considered among the mineral-producing counties of the state. It stands nineteenth on the list in this respect, however, with an output valued at $1,395,558 for the calendar year 1919. Various structural materials make up the chief items, including brick, cement, limestone, and miscellaneous stone. Among the others are asbestos, clay, coal, gypsum, manganese, mineral water, and soapstone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Clay and clay products		$193,340
Stone, miscellaneous		275,309
Other minerals*		926,909
Total value		$1,395,558

*Includes cement and mineral water.

DEL NORTE.

Area: 1,024 square miles.
Population: 2,759 (1920 census).
Location: Extreme northwest corner of state.
Transportation: Wagon and mule back; steamer from Crescent City.

Del Norte rivals Alpine County in regard to inaccessibility. Like the latter county also, given transportation and kindred facilities, this portion of the state presents a wide field for development along mining lines especially. Its chief mineral resources, largely untouched, are chromite, copper, gems, gold, iron, platinum minerals, silver, and miscellaneous stone. The decrease in 1919 from the 1918 figure of $371,675 was due to chromite.

Commercial production for 1919, giving it fifty-fifth place, was as follows:

Substance	Amount	Value
Gold		[1]$500
Silver		[1]4
Stone, miscellaneous		6,300
Other minerals		67
Total value		$6,871

[1]Estimated.

EL DORADO.

Area: 1,753 square miles.
Population: 6,426 (1920 census).
Location: East-central portion of the state, northernmost of the Mother Lode counties.

El Dorado County, which contains the locality where gold in California was first heralded to the world, comes thirty-ninth on the list of counties ranked according to the value of their total mineral production during the year 1919. In addition to the segregated figures here given, a large tonnage of limestone is annually shipped from El Dorado for use in cement manufacture, and whose value is included in the state total for cement. Chromite and limestone both showed important decreases for 1919.

The mineral resources of this section, many of them undeveloped, include asbestos, barytes, chromite, clay, copper, gems, gold, iron, molybdenum, limestone, quartz crystals, quicksilver, glass-sand, slate, soapstone, silver and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Chromite	378 tons	$6,510
Gold	----------	[1]28,000
Limestone	41,025 tons	112,423
Silver	----------	[1]700
Soapstone or talc	1,600 tons	13,950
Stone, miscellaneous	----------	1,700
Other minerals	----------	1,169
Total value	----------	$164,452

[1]Estimated.

FRESNO.

Area: 5,950 square miles.
Population: 128,779 (1920 census).
Location: South-central portion of state.

Fresno County, fourth in importance as a mineral producer among the counties of California, reported an output for 1919 of eleven mineral substances, with a total value of $21,643,898, an increase over the reported 1918 production, which was worth $19,876,625. The great bulk of the above is derived from the petroleum production of the Coalinga field.

The mineral resources of this county are many, and, aside from crude oil, are in the main not yet fully developed. They include asbestos, barytes, brick, chromite, copper, gems, gold, graphite, gypsum, magnesite, natural gas, petroleum, quicksilver, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Gold		[1]$5,000
Granite		34,500
Magnesite	600 tons	5,950
Natural gas	5,191,287 M cu. ft.	411,356
Petroleum	16,091,037 bbls.	20,805,711
Silver		[1]40
Stone, miscellaneous		241,213
Other minerals*		140,128
Total value		$21,643,898

*Includes chromite and brick.
[1]Estimated.

GLENN.

Area: 1,259 square miles.
Population: 11,853 (1920 census).
Location: West side of Sacramento Valley.

Glenn County, standing forty-fourth, owes its position among the mineral-producing counties of the state mainly to the presence of large deposits of sand and gravel which are annually worked, the product being used for railroad ballast, etc. In 1917 and 1918, chromite was also an important item. In the foothills in the western portion of the county, deposits of chromite, copper, manganese, sandstone, and soapstone have been found.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$58,137
Other minerals		1,500
Total value		$59,637

HUMBOLDT.

Area: 3,634 square miles.
Population: 37,857 (1920 census).
Location: Northwestern portion of state, bordering on Pacific Ocean.

Humboldt County is almost entirely mountainous, transportation within its limits being very largely by wagon road and trail, and until recent years was reached from the outside world by steamer only. The county is rich in mineral resources, among which are brick, chromite, coal, clay, copper, gold, iron, mineral water, natural gas, petroleum, platinum, silver and miscellaneous stone.

Six mineral substances, as shown by the table given below, having a total value of $43,667, were produced in 1919, as compared with the

1918 output, worth $141,954, the decrease being due to manganese and chromite. Humboldt ranks forty-seventh among the counties of the state for the year.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Brick and clay		$9,271
Gold		[1]8,000
Silver		[1]50
Stone, miscellaneous		25,198
Other minerals*		1,148
Total value		$43,667

*Includes mineral water and natural gas.
[1]Estimated.

IMPERIAL.

Area: 4,089 square miles.
Population: 43,383 (1920 census).
Location: Extreme southeast corner of the state.

During 1919 Imperial County produced eight mineral substances having a total value of $133,236, as compared with the 1918 output, worth $109,692. Its rank is forty-first. This county contains deposits of gold, gypsum, lead, marble, pumice, salt, silver, and strontium, largely undeveloped.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Gold		[1]$200
Silver		[1]1,200
Stone, miscellaneous		63,900
Other minerals*		67,936
Total value		$133,236

*Includes brick, lead, pumice, and salt.
[1]Estimated.

INYO.

Area: 10,019 square miles.
Population: 7,031 (1920 census).
Location: Lies on eastern border of state, north of San Bernardino County.

Inyo, the second largest county in the state, and containing less than one inhabitant per square mile, is extremely interesting from a mineralogical point of view. It is noted because of the fact that within its borders are located both the highest point, Mount Whitney (elevation

14,502 feet), and the lowest point, Death Valley (elevation 290 feet below sea level), in the United States. In the higher mountainous sections are found many vein-forming minerals, and in the lake beds of Death Valley saline deposits exist.

Inyo's mineral production during the year 1919 reached a value of $2,674,835, standing twelfth among the counties of the state in this respect. The 1918 value was $5,177,676, the decrease being due mainly to lead, silver and tungsten. Its mineral resources include antimony, asbestos, barytes, borax, copper, gems, gold, gypsum, lead, marble, molybdenum, mineral water, nitre, pumice, quicksilver, salt, silver, soda, sulphur, talc, tungsten, and zinc.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	169,713 lbs.	$31,567
Gold	----------	[1]90,000
Lead	3,643,485 lbs.	193,105
Limestone	2,360 tons	12,000
Silver	----------	[1]156,000
Stone, miscellaneous	----------	7,850
Zinc	1,192,353 lbs.	87,042
Other minerals*	----------	2,097,271
Total value	----------	$2,674,835

*Includes borax, dolomite, marble, pumice, salt, soda, talc, and tungsten.
[1]Estimated.

KERN.

Area: 8,003 square miles.
Population: 54,843 (1920 census).
Location: South-central portion of state.

Kern County, because of its immensely productive oil fields, stands pre-eminent among all counties of California in the value of its mineral output, the exact figures for 1919 being $67,153,361. This is larger by nearly forty million dollars than the succeeding county on the list. This figure also is approximately four times the value of the total gold output of the entire state for 1919. The 1918 mineral output for Kern County was worth $63,410,685. The increase was due to the enhanced prices for crude oil of all grades.

Among the mineral resources, developed and undeveloped, of this section are: Antimony, asphalt, borax, brick, clay, copper, fuller's earth, gems, gold, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, natural gas, petroleum, potash, salt, silver, soapstone, soda, sulphur and tungsten.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Brick	1,709 M	$175,112
Gold		[1]230,000
Lime	86,952 bbls.	112,724
Natural gas	25,363,739 M cu. ft.	1,618,913
Petroleum	47,734,035 bbls.	64,440,947
Salt	17,000 tons	81,000
Silver		[1]457,000
Stone, miscellaneous		28,320
Other minerals*		9,345
Total value		$67,153,361

*Includes fuller's earth, limestone, and quicksilver.
[1]Estimated.

KINGS.

Area: 1,159 square miles.
Population: 22,031 (1920 census).
Location: South-central portion of the state.

Little development has taken place in Kings County along mineral lines to date. Deposits of fuller's earth, gypsum, mineral paint, natural gas, and quicksilver, of undetermined extent, have been found in the county. Some drilling for oil has been under way, but there has, as yet, been no commercial output recorded. The increase in 1919 was due to quicksilver.

In forty-sixth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Natural gas	2,550 M cu. ft.	$1,630
Other minerals		49,653
Total value		$51,283

LAKE.

Area: 1,278 square miles.
Population: 5,542 (1920 census).
Location: About fifty miles north of San Francisco Bay and the same distance inland from the Pacific Ocean.

On account of its topography and natural beauties, Lake County is sometimes referred to as the Switzerland of America. The mineral resources which exist here are many and varied, actual production being comparatively small, as shown by the table below, and composed mainly of quicksilver, and mineral water. Some of the leading minerals, found in this section, in part as yet undeveloped, are borax, chromite,

clay, copper, gems, gold, gypsum, mineral water, quicksilver, silver, and sulphur.

In forty-ninth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Mineral water	62,839 gals.	$17,471
Quicksilver	229 flasks	20,604
Stone, miscellaneous		1,200
Other minerals		100
Total value		$39,375

LASSEN.

Area: 4,531 square miles.
Population: 8,507 (1920 census).
Location: Northeast portion of state.

Lassen County is one of the little explored sections of California. Since about 1912 a railroad traversing the county north and south has been in operation, thus affording opportunity for development along mineral and other lines.

Among the mineral resources of this county are copper, gems, gypsum, gold, silver, and sulphur. In the past, some gold has been produced, but not during the last few years.

In fifty-sixth place, commercial production for 1918 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$1,100

LOS ANGELES.

Area: 4,067 square miles.
Population: 936,438 (1920 census).
Location: One of the southwestern coast counties.

Mineral production in Los Angeles County for the year 1919 amounted in value to $23,606,381 as compared with the 1918 output, worth $16,006,628. This county ranked third in the state as a mineral producer in 1919, passing Fresno, which was fourth in 1918. The advance was due to the large increase in the petroleum output and valuation.

Its output of brick and tile was over a million dollars, and that of petroleum amounted to over twenty million dollars. Among the mineral resources may be noted asphalt, barytes, borax, brick, clay, fuller's earth, gems, gold, gypsum, infusorial earth, limestone, marble, mineral paint, mineral water, natural gas, petroleum, salt, glass-sand, sandstone, serpentine, silver, soapstone, and miscellaneous stone. Some potash has been obtained from kelp.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Brick and tile		$1,185,154
Clay	11,329 tons	33,343
Mineral water	125,400 gals.	8,787
Natural gas	4,148,476 M cu. ft.	458,812
Petroleum	15,076,633 bbls.	20,805,754
Stone, miscellaneous		715,524
Other minerals*		399,007
Total value		$23,606,381

*Includes borax, gems, graphite, magnesium salts, manganese, and salt.

MADERA.

Area: 2,112 square miles.

Population: 12,203 (1920 census).

Location: East-central portion of state.

Madera County produced five mineral substances during the year 1919, having a total value of $110,683, as compared with the 1918 output, worth $114,327. The decrease is due to a dropping off in the output of copper, though granite increased. This county contains deposits of copper, gold, iron, lead, molybdenum, pumice, silver, and building stone.

In forty-second place, commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	175,405 lbs.	$32,625
Gold		[1]8,000
Granite		64,358
Silver		[1]4,200
Stone, miscellaneous		1,500
Total value		$110,683

[1]Estimated.

MARIN.

Area: 529 square miles.

Population: 27,342 (1920 census).

Location: Adjoins San Francisco on the north.

Mineral production in Marin County during the year 1919 reached a value of $228,974, as compared to the 1918 output, worth $176,183, the increase being due to crushed rock, and brick. This county is not especially prolific in minerals, although among its resources along these lines are brick, gems, manganese, mineral water, soapstone, and miscellaneous stone.

In thirty-seventh place, commercial production for 1919 was:

Substance	Amount	Value
Stone, miscellaneous		$127,111
Other minerals*		101,863
Total value		$228,974

*Includes brick and mineral water.

MARIPOSA.

Area: 1,463 square miles.
Population: 2,775 (1920 census).
Location: Most southerly of the Mother Lode counties. East-central portion of state.

Mariposa County is one of the distinctly 'mining' counties of the state, although it stands but thirtieth on the list of counties in regard to the value of its mineral output for 1919, with a total of $410,535, as compared with the 1918 figures of $352,504.

Its mineral resources are varied; among the more important items being barytes, copper, gems, gold, lead, marble, silver, slate, soapstone, and miscellaneous stone.

The Yosemite Valley is in Mariposa County.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	24,879 lbs.	$4,627
Gold	----------	[1]400,200
Silver	----------	[1]5,500
Stone, miscellaneous	----------	400
Other minerals	----------	8
Total value	----------	$410,535

[1]Estimated.

MENDOCINO.

Area: 3,453 square miles.
Population: 24,116 (1920 census).
Location: Joins Humboldt County on the south and bounded by the Pacific Ocean on the west.

Mendocino's annual mineral production has usually been small, the 1919 output being valued at $14,214, ranking it fifty-first among the counties. That of 1918 was worth $108,388, the decrease being due to chromite and manganese.

Deposits of, in part undetermined value, of asbestos, chromite, coal, copper, graphite, magnesite, and mineral water have been found, as well as traces of gold and silver.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous	----------	$7,000
Other minerals*	----------	7,214
Total value	----------	$14,214

*Includes chromite and platinum.

MERCED.

Area: 1,995 square miles.
Population: 24,579 (1920 census).
Location: About the geographical center of the state.

Merced County as a whole lies in the San Joaquin Valley, and it figures as one of the lesser mineral-producing counties of the state. The 1919 mineral output was valued at $40,350. The decrease from the value of $74,849 in 1918 was due to gold. Gold, platinum, and silver, obtained by dredging, for several years were among the important items. Undeveloped deposits of antimony, magnesite, quicksilver, and limestone have been noted in this county in addition to the foregoing.

In forty-eighth place, commercial production during 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$40,350

MODOC.

Area: 3,823 square miles.
Population: 5,425 (1920 census).
Location: The extreme northwest corner of the state.

Modoc County, like Lassen, has only in recent years had the benefit of communication with the outside world by rail. Among its known mineral resources are: Clay, coal, gold, iron, quicksilver, salt, and silver.

In fifty-third place, commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$550
Other minerals*		8,120
Total value		$8,670

*Includes gold, salt, and silver.

MONO.

Area: 3,030 square miles.
Population: 960 (1920 census).
Location: Is bordered by the State of Nevada on the east and is about in the central portion of the state measured on a north and south line.

Gold mining has been carried on in portions of Mono County for many years, although taken as a whole it lies in a rather inaccessible country and has been but superficially explored. It is in the continuation of the highly mineralized belt which was noted in Inyo County

and contains among other mineral resources barytes, clay, copper, gold, limestone, molybdenum, pumice, salt, silver, and travertine.

In forty-fifth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	539 lbs.	$100
Gold	----------	[1]30,000
Lead	1,556 lbs.	82
Silver	----------	[1]22,500
Total value	----------	$52,682

[1]Estimated.

MONTEREY.

Area: 3,330 square miles.

Population: 27,980 (1920 census).

Location: West-central portion of state, bordering on Pacific Ocean.

Monterey County produced eight mineral substances during the year 1919, having a total value of $133,504, as compared with the 1918 output worth $119,687. Its mineral resources include brick, clay, copper, coal, dolomite, feldspar, fuller's earth, gold, silver, gypsum, infusorial earth, limestone, mineral water, petroleum, quicksilver, glass-sand, sandstone, silver, and miscellaneous stone.

In fortieth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Dolomite	8,280 tons	$29,120
Stone, miscellaneous	----------	73,031
Other minerals*	----------	43,353
Total value	----------	$148,504

*Includes barytes, coal, feldspar, diatomaceous earth, salt, and silica.

NAPA.

Area: 783 square miles.

Population: 20,678 (1920 census).

Location: Directly north of San Francisco Bay—one of the 'bay counties.'

Napa, because of its production of structural and industrial materials and quicksilver, stands thirty-fifth on the list of mineral-producing counties in California. Its mineral resources include chromite, copper, cement, gypsum, magnesite, mineral water, quicksilver, sandstone, and miscellaneous stone.

In 1919, the value of the output decreased to $275,303 from the 1918 figure of $1,676,367, due mainly to cement and magnesite.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Magnesite	10,112 tons	$86,752
Mineral water	76,860 gals.	60,395
Quicksilver	644 flasks	58,140
Stone, miscellaneous		70,016
Total value		$275,303

NEVADA.

Area: 974 square miles.

Population: 10,860 (1920 census).

Location: North of Lake Tahoe, on the eastern border of the state.

Nevada, one of the mountain counties of California, has in recent years, alternated with Amador in the gold lead, but both were passed by Yuba in 1918–1919. Nevada County stands ninth on the list in regard to the value of its total mineral output, with a figure of $3,068,010, as compared with the 1918 production worth $3,301,651. The decrease is due mainly to gold and chromite.

While this county actually produces mainly gold and silver, its resources cover a wide scope, including antimony, asbestos, barytes, bismuth, chromite, clay, copper, gems, iron, lead, mineral paint, pyrite, soapstone, and tungsten.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Gold		[1]$3,000,000
Silver		[1]54,000
Stone, miscellaneous		1,976
Other minerals*		12,034
Total value		$3,068,010

*Includes asbestos, barytes, chromite, copper, granite, lead, and platinum.
[1]Estimated.

ORANGE.

Area: 795 square miles.

Population: 61,375 (1920 census).

Location: South-western portion of state, bordering Pacific Ocean.

Orange County is one of the many in California which on casual inspection appears to be anything but a mineral-producing section. It stands, however, as the second county in the state in regard to the total value of mineral output for 1919, its highly productive oil fields making such a condition possible.

This county, in company with most of the other oil counties, shows a gain in 1919, with a total value of mineral products of $27,848,727 from the 1918 output, worth $22,914,660. It passed Shasta County in 1917, which previously for a number of years, had exceeded all other counties in California, except Kern.

Aside from the substances actually produced and noted in the table below, coal, gypsum, iron, infusorial earth, sandstone, and tourmaline have been found in Orange County.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Clay and clay products		$18,489
Natural gas	12,039,355 M. cu. ft.	837,439
Petroleum	14,458,722 bbls.	26,893,223
Stone, miscellaneous		1,944
Other minerals*		97,632
Total value		$27,848,727

*Includes lead and potash.

PLACER.

Area: 1,395 square miles.

Population: 18,584 (1920 census).

Location: Eastern border of state directly west of Lake Tahoe.

While standing only twenty-ninth on the list of mineral-producing counties, Placer contains a wide variety of mineral substances, some of which have not been commercially exploited. Its leading products are gold, chromite, granite, copper, and clay. Other mineral resources are: Asbestos, brick, chromite, coal, gems, iron, lead, limestone, magnesite, manganese, marble, quartz crystals, glass-sand, silver, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Chromite	1,018 tons	$24,000
Clay and clay products		98,513
Gold		[1]230,000
Granite		36,233
Silver		[1]21,000
Stone, miscellaneous		4,330
Other minerals		1,055
Total value		$415,131

[1]Estimated.

PLUMAS.

Area: 2,594 square miles.
Population: 5,681 (1920 census).
Location: Northeastern border of state, south of Lassen County.

A considerable portion of the area of Plumas County lies in the high mountains, and deposits of the metals, especially gold and copper, are found there. Lack of transportation and other facilities have retarded its growth, but its future is decidedly promising. Mineral production for 1919 was valued at $2,183,750, as compared with the 1918 output, worth $3,092,694, the decrease being due mainly to copper, which dropped the county from twelfth to fifteenth place in rank. In 1919 Plumas passed Shasta in the copper lead, owing to the Shasta smelters being closed down.

Among its mineral resources are: Chromite, copper, gold, granite, iron, lead, limestone, manganese, molybdenum, platinum, silver, and zinc.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	10,193,951 lbs.	$1,896,075
Gold		[1]130,000
Silver		[1]155,000
Stone, miscellaneous		850
Other minerals*		1,825
Total value		$2,183,750

*Includes limestone and manganese.
[1]Estimated.

RIVERSIDE.

Area: 7,240 square miles.
Population: 60,297 (1920 census).
Location: Southern portion of state.

Riverside is the fourth county in the state in size and the thirteenth in regard to the total value of mineral output for 1919. Within its borders are included mountain, desert, and agricultural land. Its mineral resources include metals, structural and industrial materials, and salines, some of the more important being borax, brick, cement, clay, coal, copper, feldspar, gems, gold, gypsum, iron, lead, limestone, manganese, magnesite, marble, mineral paint, mineral water, salt, glass-sand, soapstone, silver, miscellaneous stone, and tin. In point of variety Riverside County led all others with nineteen different minerals commercially produced in 1919, passing San Bernardino which dropped from twenty-five to seventeen.

The increase in 1919 over the 1918 value of $1,689,042 is due mainly to cement.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Brick and tile		$224,379
Clay	42,207 tons	61,006
Copper	10,590 lbs.	1,970
Gold		[1]400
Granite		17,975
Gypsum	200 tons	425
Manganese	1,808 tons	49,324
Silica	3,034 tons	15,112
Silver		[1]1,500
Stone, miscellaneous		102,399
Other minerals*		2,103,760
Total value		$2,578,250

*Includes cement, coal, feldspar, fuller's earth, lead, magnesite, mineral water and potash.
[1]Estimated.

SACRAMENTO.

Area: 983 square miles.
Population: 90,978 (1920 census).
Location: North-central portion of state.

Sacramento stands fourteenth among the counties of the state as a mineral producer, the output, principally gold, for 1919 being valued at $2,275,827, as compared with the 1918 production, worth $2,102,597. In regard to gold output alone this county ranks fourth, being exceeded only by Yuba, Amador, and Nevada counties. Its mineral resources include: Brick, clay, gold, natural gas, platinum, silver and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Clay and clay products		$113,000
Gold		[1]1,820,000
Silver		[1]5,000
Stone, miscellaneous		276,432
Other minerals*		61,395
Total value		$2,275,827

*Includes natural gas and platinum.
[1]Estimated.

SAN BENITO.

Area: 1,392 square miles.
Population: 8,995 (1920 census).
Location: West-central portion of state.

Although twenty-first among the counties of the state in regard to value of total mineral production, San Benito leads in one important branch of the mineral industry, namely, quicksilver.

Its other mineral resources, many of them undeveloped, include: Antimony, bituminous rock, chromite, coal, gypsum, gems, limestone, mineral water, soapstone, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Dolomite	7,000 tons	$24,500
Quicksilver	7,409 flasks	668,989
Stone, miscellaneous	----------	164,300
Other minerals*	----------	418,687
Total value	----------	$1,276,476

*Includes cement, magnesite, and mineral water.

SAN BERNARDINO.

Area: 20,157 square miles.

Population: 73,401 (1920 census).

Location: Southeastern portion of state.

San Bernardino, by far the largest county in the state, in area, ranks sixth as regards the value of its mineral output for 1919 with a total of $4,236,199, as compared with the 1918 total of $7,632,790. The decrease is due mainly to potash and tungsten.

San Bernardino for several years led all other counties in the state in point of variety of minerals, producing commercially during 1918, a total of 25 different substances but dropped to 17 in 1919, compared to 19 for Riverside County.

This county, consisting largely of mountain and desert country, is highly mineralized, the following being included among its resources: Asbestos, barytes, borax, brick, cement, clay, copper, gems, gold, granite, gypsum, iron, lead, limestone, manganese, marble, mineral paint, mineral water, nitre, potash, salt, glass-sand, soapstone, soda, miscellaneous stone, strontium, talc, tungsten, vanadium, and zinc.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Cement	1,078,943 bbls.	$1,717,998
Copper	256,933 lbs.	47,790
Gold	----------	[1]25,000
Gypsum	19,613 tons	50,154
Lead	105,796 lbs.	5,607
Mineral water	800,060 gals.	32,006
Potash	21,171 tons	1,670,919
Silver	----------	[1]40,000
Talc	3,601 tons	19,845
Stone, miscellaneous	----------	183,388
Other minerals*	----------	443,492
Total value	----------	$4,236,199

*Includes borax, clay, dolomite, gems, lime and tungsten.
[1]Estimated.

SAN DIEGO.

Area: 4,221 square miles.
Population: 112,248 (1920 census).
Location: Extreme southwest corner of state.

San Diego ranks thirty-first in the total value of its mineral output. This figure for 1919 equaled $343,230, as compared with the 1918 output worth $1,942,150, the drop being due to potash. In 1918 for the only time in several years, there was no production of gems, in which San Diego County has lead the state. Aside from minerals commercially produced, as shown below, San Diego County contains occurrences of bismuth, lithia, marble, nickel, soapstone, and tin. Potash has been produced from kelp.

A development of the past four years is the shipping of pebbles for grinding mills.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Clay and clay products		$62,929
Granite		15,215
Salt	12,400 tons	52,800
Stone, miscellaneous		141,996
Other minerals*		70,290
Total value		$343,230

*Includes copper, gems, gold (estimated), lithia, mineral water, potash, silica, and silver (estimated).

SAN FRANCISCO.

Area: 43 square miles.
Population: 506,676 (1920 census).

Surprising as it may appear at first glance, San Francisco County is listed among the mineral producing sections of the state, actual production consisting of crushed rock, sand, and gravel. Small quantities of various valuable mineral substances are found here, including cinnabar, gypsum, lignite, and magnesite, none, however, in paying quantities.

In fifty-third place, commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$65,541

SAN JOAQUIN.

Area: 1,448 square miles.
Population: 79,905 (1920 census).
Location: Central portion of state.

San Joaquin County reported a mineral production for the year 1919 having a total value of $449,000, as compared with the 1918 output, worth $601,973, the decrease being due mainly to brick and manganese. Comparatively few mineral substances are found here, the chief ones being brick, clay, manganese, natural gas, glass-sand, and miscellaneous stone. Gold, platinum, and silver are obtained by dredging in the Mokelumne River, which forms the boundary between this county and Amador on the northeast.

In twenty-eighth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Brick		$231,478
Manganese	343 tons	10,274
Natural gas	200,943 M. cu. ft.	76,200
Stone, miscellaneous		59,510
Other minerals*		71,538
Total value		$449,000

*Includes gold, platinum, and silver.

SAN LUIS OBISPO.

Area: 3,334 square miles.
Population: 21,893 (1920 census).
Location: Bordered by Kern County on the east and the Pacific Ocean on the west.

The total value of the mineral production of San Luis Obispo County in 1919 was $212,430, as compared with the 1918 output, worth $858,679, the decrease being due to chromite and manganese. Among its mineral resources both developed and undeveloped, are: Asphalt, bituminous rock, brick, chromite, coal, copper, gypsum, infusorial earth, iron, limestone, marble, mineral water, onyx, petroleum, quicksilver, and miscellaneous stone.

In thirty-eighth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Chromite	1,158 tons	$26,431
Petroleum	31,656 bbls.	32,922
Stone, miscellaneous		20,300
Other minerals*		132,777
Total value		$212,430

*Includes bituminous rock, manganese, quicksilver, sandstone, and soda.

SAN MATEO.

Area: 447 square miles.
Population: 36,781 (1920 census).
Location: Peninsula, adjoined by San Francisco on the north.

San Mateo's most important mineral products are stone, and salt, the last-named being derived by evaporation from the waters of San Francisco Bay. The total value of all mineral production during 1919 equaled $241,671, as compared with the 1918 figures of $193,812.

Small amounts of barytes, chromite, infusorial earth, and quicksilver have been noted in addition to the items of economic value given below. Bricks have also been produced commercially.

In thirty-sixth place, commercial production for 1919 was as follows:

Substance	Amount	Value
Salt	30,238 tons	$136,190
Stone, miscellaneous		42,235
Other minerals*		63,246
Total value		$241,671

*Includes magnesium salts and potash.

SANTA BARBARA.

Area: 2,740 square miles.
Population: 41,097 (1920 census).
Location: South-western portion of state, joining San Luis Obispo on the south.

Santa Barbara County owes its position of fifth in the state in regard to its mineral output to the presence of productive oil fields within its boundaries. The total value of its mineral production during the year 1919 was $7,594,917, as compared with the 1918 output of $10,051,831. Santa Barbara was the only important oil-producing county to show a decrease in petroleum valuation for 1919.

Aside from the mineral substances listed below, Santa Barbara County contains asphalt, diatomaceous earth, gilsonite, gypsum, magnesite, and quicksilver in more or less abundance.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Mineral water	82,147 gals.	$81,041
Natural gas	4,084,709 M. cu. ft.	336,092
Petroleum	6,089,082 bbls.	6,850,217
Potash	298 tons	30,128
Stone, miscellaneous		29,900
Other minerals*		267,539
Total value		$7,594,917

*Includes bituminous rock, chromite, brick, diatomaceous earth, and limestone.

SANTA CLARA.

Area: 1,328 square miles.
Population: 100,588 (1920 census).
Location: West-central portion of state.

Santa Clara County reported a mineral output for 1919 of $1,048,571, as compared with the 1918 figures of $1,759,568, the decrease being due to potash, manganese and quicksilver.

This county, lying largely in the Coast Range Mountains, contains a wide variety of mineral substances, including brick, chromite, clay, limestone, magnesite, manganese, mineral water, petroleum, quicksilver, soapstone, and miscellaneous stone. It stood second in quicksilver yield for the year.

In twenty-second place, commercial production for 1919 was as follows:

Substance	Amount	Value
Brick	7,250 M.	$65,000
Clay	2,532 tons	2,232
Magnesite	10,912 tons	128,924
Manganese	102 tons	3,321
Petroleum	16,724 bbls.	26,695
Quicksilver	3,012 flasks	271,762
Stone, miscellaneous	----------	73,237
Other minerals*	----------	477,400
Total value	----------	$1,048,571

*Includes limestone, mineral water, and potash.

SANTA CRUZ.

Area: 435 square miles.
Population: 26,269 (1920 census).
Location: Bordering Pacific Ocean, just south of San Mateo County.

The mineral output of Santa Cruz County, a portion of which is itemized below, amounted to a total value of $2,245,056, giving the county a standing of fifteenth among all others in the state in this regard.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Lime	150,271 bbls.	$234,039
Limestone	5,527 tons	12,690
Stone, miscellaneous	----------	17,074
Other minerals*	----------	1,981,253
Total value	----------	$2,245,056

*Includes bituminous rock, cement, and potash.

SHASTA.

Area: 3,858 square miles.
Population: 13,311 (1920 census).
Location: North-central portion of state.

Shasta County stood eleventh in California among the mineral-producing counties for 1919, with an output valued at $2,912,718, as compared with the 1918 production worth $8,098,671. The marked decrease both in 1918 and 1919 was due to the falling off in the output of copper, the large plants of the Mammoth and Mountain copper companies being shut down most of the year. Not taking petroleum into account, Shasta for a number of years lead all of the counties by a wide margin; but in 1919 was passed by San Bernardino, Yuba, Amador, and Nevada among the 'metal' counties.

Shasta's mineral resources include: Asbestos, barytes, brick, chromite, coal, copper, gold, iron, lead, lime, limestone, mineral water, molybdenum, pyrite, silver, soapstone, miscellaneous stone, and zinc.

Lassen Peak is located in southeastern Shasta County.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	8,673,342 lbs.	$1,613,242
Gold	----------	[1]525,000
Lime and limestone	----------	29,100
Platinum	121 oz.	21,075
Pyrite	138,046 tons	497,398
Silver	----------	[1]155,000
Stone, miscellaneous	----------	31,750
Other minerals*	----------	40,153
Total value	----------	$2,912,718

*Includes barytes, brick, iron ore, lead, mineral water, and zinc.
[1]Estimated.

SIERRA.

Area: 923 square miles.
Population: 1,783 (1920 census).
Location: Eastern border of state, just north of Nevada County.

Sierra County reported a mineral production of $292,950, consisting mainly of gold and silver, during the year 1919, as compared with the 1918 output, worth $331,501, the decrease being due to chromite. Considering gold output alone, this county stands tenth; and as to total mineral yield thirty-third.

Aside from the metals itemized below, Sierra County contains deposits of asbestos, chromite, copper, iron, lead, platinum, minerals, serpentine, and talc.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Gold		[1]$290,000
Silver		[1]2,200
Stone, miscellaneous		750
Total value		$292,950

[1]Estimated.

SISKIYOU.

Area: 6,256 square miles.

Population: 18,545 (1920 census).

Location: Extreme north-central portion of state, next to Oregon boundary.

Siskiyou, fifth county in California in regard to size, located in a highly mineralized and mountainous country, ranks twenty-fourth in regard to the value of its mineral output for 1919. The advance in rank from thirty-ninth in 1917, was due to chromite, notwithstanding the losses in copper, gold and miscellaneous stone. The decrease in 1919 was due mainly to stoppage of chromite mining. Although the county is traversed by a transcontinental railroad in a north and south line, the mineral-bearing sections are almost without exception far from transportation and other facilities. A large part of the county is accessible by trail alone. Future development and exploitation will doubtless increase the productiveness of this part of the state to a great degree.

Mount Shasta is located in Siskiyou County.

Among Siskiyou's mineral resources are: Chromite, clay, coal, copper, gems, gold, lead, limestone, manganese, marble, mineral water, pumice, quicksilver, sandstone, silver, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Chromite	510 tons	$13,379
Gold		[1]350,000
Mineral water	451,500 gals.	90,375
Platinum	7 oz.	1,015
Silver		[1]16,000
Stone, miscellaneous		26,405
Other minerals*		111,294
Total value		$608,468

*Includes copper, limestone, pumice, and quicksilver.
[1]Estimated.

SOLANO.

Area: 822 square miles.
Population: 40,602 (1920 census).
Location: Touching San Francisco Bay on the northeast.

Solano, while mostly valley land, produced mineral substances during the year 1919 to the total value of $1,672,084, ranking eighteenth among the counties of the state, the increase over 1918 being due to cement. Among her mineral resources are: Brick, cement, clay, fuller's earth, limestone, mineral water, natural gas, onyx, petroleum, quicksilver, salt, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$44,156
Other minerals*		1,627,928
Total value		$1,672,084

*Includes cement, fuller's earth, mineral water, natural gas, and quicksilver.

SONOMA.

Area: 1,577 square miles.
Population: 51,990 (1920 census).
Location: South of Mendocino County, bordering on the Pacific Ocean.

Sonoma ranked thirty-fourth among the counties of California during the year 1919, with a mineral production of $286,038, as compared with its 1918 output worth $586,391, the decrease being due mainly to chromite, magnesite, and quicksilver. More paving blocks have been turned out here than in any other section of the state.

Among Sonoma's mineral resources are: Brick, chromite, clay, copper, graphite, infusorial earth, magnesite, manganese, marble, mineral paint, mineral water, quicksilver, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Building stone and curbing		$62
Mineral water	96,800 gals.	22,820
Quicksilver	1,418 flasks	119,142
Stone, miscellaneous		144,014
Total value		$286,038

STANISLAUS.

Area: 1,450 square miles.
Population: 43,557 (1920 census).
Location: Center of state, bounded on south by Merced County.

Gold has usually been the chief mineral product of Stanislaus County, but it was exceeded in 1918-1919 by manganese. Brick, clay, gypsum, iron, mineral paint, quicksilver, and silver are found here to some extent as well. This county, for 1919 ranks twenty-fifth in the state in regard to value of minerals, with an output of $590,326 as compared with $453,913 in 1918, the increase being due mainly to gold and manganese. Gold, platinum, and silver are obtained mainly by dredging.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Magnesite	2,031 tons	$20,831
Manganese	8,921 tons	374,584
Stone, miscellaneous		28,922
Other minerals*		165,989
Total value		$590,326

*Includes gold (estimated), mineral paint, platinum, and silver (estimated).

SUTTER.

Area: 608 square miles.
Population: 10,115 (1920 census).
Location: Bounded by Butte County on the north and Sacramento on the south.

Sutter is one of only two counties in the state which for a number of years reported no commercial output of some kind of mineral substance. In 1917 some crushed rock was taken out, from the Marysville Buttes, but there was no production in 1918, nor 1919. Both coal and clay exist here, but deposits of neither mineral have been placed on a productive basis.

TEHAMA.

Area: 2,893 square miles.
Population: 12,882 (1920 census).
Location: North-central portion of the state, bounded on the north by Shasta.

Tehama stands fifty-second among the fifty-six mineral-producing counties of the state for 1919, when its output was valued at $9,000, as

compared with the 1918 yield worth $157,591. The advance in 1918 and the drop in 1919 was due to chromite.

Among its mineral resources are listed: Brick, chromite, copper, gold, manganese, marble, mineral water, salt, and miscellaneous stone.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$7,500
Other minerals		1,500
Total value		$9,000

TRINITY.

Area: 3,166 square miles.

Population: 2,551 (1920 census).

Location: Northwestern portion of state.

Trinity, like Siskiyou County, requires transportation facilities to further the development of its many and varied mineral resources. Deposits of asbestos, barytes, chromite, copper, gold, mineral water, platinum, quicksilver, silver, and building stone are known here, but with the exception of gold, chromite, copper, and platinum, very little active production of these mineral substances has been made as yet. The 1919 output of $536,783 shows a decrease from the 1918 figure of $707,524, due mainly to chromite and copper.

In the twenty-sixth place, commercial output for 1919 was:

Substance	Amount	Value
Gold		[1]$500,000
Silver		[1]7,500
Stone, miscellaneous		11,839
Other minerals*		17,444
Total value		$536,783

*Includes copper, mineral water, platinum, and quicksilver.
[1]Estimated.

TULARE.

Area: 4,856 square miles.

Population: 59,031 (1920 census).

Location: Bounded by Inyo on the east, Kern on the south, Fresno on the north.

Tulare stands thirty-second on the list of mineral-producing counties, the drop from the 1918 value being due to magnesite. This county's mineral resources, among others, are: Brick, clay, copper, feldspar, graphite, gems, limestone, magnesite, marble, quartz, glass-sand, soapstone, miscellaneous stone, and zinc. Tulare for a number of years has

led the state in magnesite output, except in 1918, when it was passed by Napa County.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Brick and tile		$34,978
Limestone	10,347 tons	46,388
Magnesite	18,765 tons	186,601
Natural gas	700 M. cu. ft.	295
Stone, miscellaneous		10,811
Other minerals*		51,928
Total value		$331,001

*Includes chromite, feldspar, and granite.

TUOLUMNE.

Area: 2,190 square miles.

Population: 7,768 (1920 census).

Location: East-central portion of state—Mother Lode district.

Tuolumne ranks twenty-seventh among the counties of the state relative to its total value of mineral output. As a producer of marble its standing is first. The decrease in 1919 to $459,396 from the 1918 figure of $602,278 was due to chromite.

Chromite, clay, copper, gold, lead, limestone, marble, mineral paint, platinum, soapstone, silver, and miscellaneous stone, are among its mineral resources.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Gold		[1]$250,000
Lime and limestone		110,746
Silver		[1]17,000
Stone, miscellaneous		2,700
Other minerals*		78,950
Total value		$459,396

*Includes chromite, copper, granite, and marble.
[1]Estimated.

VENTURA.

Area: 1,878 square miles.

Population: 28,724 (1920 census).

Location: Southwestern portion of state, bordering on Pacific Ocean.

Ventura is the tenth county in the state in respect to the value of its mineral production for 1919, the exact figure being $3,017,074, as compared with the output for 1918, worth $2,186,311, the advance being due to petroleum.

The highest gravity petroleum produced in the state is found here.

Among its other mineral resources are: Asphalt, borax, brick, clay, mineral water, natural gas, sandstone, and miscellaneous stone.

The commercial production for 1919 was as follows:

Substance	Amount	Value
Clay and clay products		$4,550
Natural gas	1,038,574 M. cu. ft.	252,240
Petroleum	1,685,073 bbls.	2,755,094
Stone, miscellaneous		5,000
Other minerals		190
Total value		$3,017,074

YOLO.

Area: 1,014 square miles.

Population: 17,105 (1920 census).

Location: Sacramento Valley, bounded by Sutter on the east and Colusa on the north.

The mineral production from Yolo County during the year 1919 consisted mainly of quicksilver and miscellaneous stone, valued at $25,466, ranking it in fiftieth place. Deposits of undetermined value of iron and sandstone have been discovered within the confines of this county.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$5,600
Other minerals		19,866
Total value		$25,466

YUBA.

Area: 639 square miles.

Population: 10,375 (1920 census).

Location: Lies west of Sierra and Nevada counties; south of Plumas.

Yuba is seventh of the fifty-six mineral producing counties of the state, and leads in regard to gold output, surpassing both Nevada and Amador counties in 1918–1919 in gold yield. Iron and clay deposits have been reported in this county, aside from the following commercial production shown for the year 1919:

Substance	Amount	Value
Gold		[1]$3,875,000
Platinum	125 oz.	13,098
Silver		[1]15,000
Stone, miscellaneous		40,439
Total value		$3,943,537

[1]Estimated.

CHAPTER EIGHT.

APPENDIX.

MINING BUREAU ACT.

Chapter 679.

[Stats., 1913.]

An act establishing a state mining bureau, creating the office of state mineralogist, fixing his salary and prescribing his powers and duties; providing for the employment of officers and employees of said bureau, making it the duty of persons in charge of mines, mining operations and quarries to make certain reports, providing for the investigation of mining operations, dealings and transactions and the prosecution for defrauding, swindling and cheating therein, creating a state mining bureau fund for the purpose of carrying out the provisions of this act and repealing an act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all acts amendatory thereof and supplemental thereto or in conflict herewith.

[Approved June 16, 1913. In effect August 10, 1913.]

The people of the State of California do enact as follows:

SECTION 1. There is hereby created and established a state mining bureau. The chief officer of such bureau shall be the state mineralogist, which office is hereby created.

SEC. 2. It shall be the duty of the governor of the State of California and he is hereby empowered to appoint a citizen and resident of this state, having a practical and scientific knowledge of mining, to the office of state mineralogist. Said state mineralogist shall hold his office at the pleasure of the governor. He shall be a civil executive officer. He shall take and subscribe the same oath of office as other state officers. He shall receive for his services a salary of three hundred dollars ($300) per month, to be paid at the same time and in the same manner as the salaries of other state officers. He shall also receive his necessary traveling expenses when traveling on the business of his office. He shall give bond for the faithful performance of his duties in the sum of ten thousand dollars ($10,000), said bond to be approved by the governor of the State of California.

SEC. 3. Said state mineralogist shall employ competent geologists, field assistants, qualified specialists and office employees when necessary in the execution of his plans and operations of the bureau, and fix their compensation. The said employees shall be allowed their necessary traveling expenses when traveling on the business of said department and shall hold office at the pleasure of said state mineralogist.

SEC. 4. It shall be the duty of said state mineralogist to make, facilitate, and encourage, special studies of the mineral resources and mineral industries of the state. It shall be his duty: to collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use; to make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the state mining bureau; to provide a library of books, reports, drawings, bearing upon the mineral industries, and sciences of mineralogy and geology, and arts of mining and metallurgy, such library constituting the library of the state mining bureau; to make a collection of models, drawings and descriptions of the mechanical appliances used in mining and metallurgical processes; to preserve and so maintain such collections

and library as to make them available for reference and examination, and open to public inspection at reasonable hours; to maintain, in effect, a bureau of information concerning the mineral industries of this state, to consist of such collections and library, and to arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it; to issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this state.

SEC. 5. It is hereby made the duty of the owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character, within the state, to forward to the state mineralogist, upon his request, at his office not later than the thirtieth day of June, in each year, a detailed report upon forms which will be furnished showing the character of the mine, the number of men then employed, the method of working such mine and the general condition thereof, the total mineral production for the past year, and such owner, lessor, lessee, agent, manager or other person in charge of any mine within the state must furnish whatever information relative to such mine as the state mineralogist may from time to time require for the proper discharge of his official duties. Any owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character within the state, who fails to comply with the above provisions shall be deemed guilty of a misdemeanor.*

SEC. 6. The state mineralogist now performing the duties of the office of state mineralogist shall perform the duties of the office of state mineralogist as in this act provided until the appointment and qualification of his successor as in this act provided.

SEC. 7. The said state mineralogist shall take possession, charge and control of the offices now occupied and used by the board of trustees and state mineralogist and the museum, library and laboratory of the mining bureau located in San Francisco as provided for by a certain act of the legislature approved March 23, 1893, and hereafter referred to in section fourteen hereof, and shall maintain such offices, museum, library and laboratory for the purposes provided in this act.

SEC. 8. Said state mineralogist or qualified assistant shall have full power and authority at any time to enter or examine any and all mines, quarries, wells, mills, reduction works, refining works and other mineral properties or working plants in this state in order to gather data to comply with the provisions of this act.

SEC. 9. The state mineralogist shall make a biennial report to the governor on or before the fifteenth day of September next preceding the regular session of the legislature.

SEC. 10. All moneys received by the state mining bureau or any officer thereof (except such as may be paid to them by the state for disbursement) shall be receipted for by the state mineralogist or other officer authorized by him to act in his place and at least once a month accounted for by him to the state controller and paid into the state treasury to the credit of a fund which is hereby created and designated "state mining bureau fund." All moneys now in the possession of the state mining bureau or any officer thereof received from any source whatsoever, shall be immediately paid over to the state mineralogist and by him accounted for to the controller and paid into the state treasury to the credit of said fund. Said fund shall be used and is hereby appropriated for the use of said bureau in carrying out the purposes of this act.

SEC. 11. The said state mineralogist is hereby authorized and empowered to receive on behalf of this state, for the use and benefit of the state mining bureau, gifts, bequests, devices and legacies of real or other property and to use the same in accordance with the wishes of the donors, and if no instructions are given by said donors, to manage, use, and dispose of the gifts and bequests and legacies for the best interests of said state mining bureau and in such manner as he may deem proper.

*Sec. 19 of the Penal Code of California provides: "Except in cases where a different punishment is prescribed by this code, every offense declared to be a misdemeanor is punishable by imprisonment in a county jail not exceeding six months, or by a fine not exceeding five hundred dollars, or by both."

SEC. 12. The state mineralogist may, whenever he deems it advisable, prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the state.

SEC. 13. The state mineralogist is hereby empowered to fix a price upon and to dispose of to the public, at such price, any and all publications of the state mining bureau, including reports, bulletins, maps, registers or other publications, such price shall approximate the cost of publication and distribution. Any and all sums derived from such disposition, or from gifts or bequests made, as hereinbefore provided must be accounted for by said state mineralogist and turned over to the state treasurer to be credited to the mining bureau fund as provided for in section ten. He is also empowered to furnish without cost to public libraries the publications of the bureau, and to exchange publications with other geological surveys and scientific societies, etc.

SEC. 14. The state mineralogist provided for by this act shall be the successor in interest of the board of trustees of the state mining bureau, and the state mineralogist, under and by virtue of that certain act, entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management, and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all books, papers, documents, personal property, records, and property of every kind and description obtained or possessed, or held or controlled by the said board of trustees of the said state mining bureau, and the state mineralogist, and the clerks and employees thereof, under the provisions of said act of March 23, 1893, or any act supplemental thereto or amendatory thereof, shall immediately be turned over and delivered to the said state mineralogist herein provided for, who shall have charge and control thereof.

SEC. 15. That certain act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, and to provide for the appointment, duties and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction, and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, together with all acts amendatory thereof and supplemental thereto and all acts in conflict herewith are hereby repealed.

APPENDIX.

PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU.

Publications of this Bureau will be sent on receipt of the requisite amount. Only stamps, coin or money orders will be accepted in payment. The prices, noted, include delivery charges to all parts of the United States.

Money orders should be made payable to the STATE MINING BUREAU.

Personal checks will not be accepted.

REPORTS.

Asterisk (*) indicates the publication is out of print.

			Price
*Report	I.	Henry G. Hanks. 1880.	
*Report	II.	Henry G. Hanks. 1882.	
*Report	III.	Henry G. Hanks. 1883.	
*Report	IV.	Henry G. Hanks. 1884.	
*Report	V.	Henry G. Hanks. 1885.	
*Report	VI.	Part 1. Henry G. Hanks. 1886.	
*Report	VI.	Part 2. Wm. Irelan, Jr. 1886.	
*Report	VII.	Wm. Irelan, Jr. 1887.	
*Report	VIII.	Wm. Irelan, Jr. 1888.	
*Report	IX.	Wm. Irelan, Jr. 1889.	
*Report	X.	Wm. Irelan, Jr. 1890.	
Report	XI.	Wm. Irelan, Jr. 1892. (First biennial)	$1.00
*Report	XII.	J. J. Crawford. 1894. (Second biennial)	----
*Report	XIII.	J. J. Crawford. 1896. (Third biennial)	----

Chapters of State Mineralogist's Report, Biennial period, 1913-1914, Fletcher Hamilton:

Mines and Mineral Resources of Imperial and San Diego Counties.—F. J. H. Merrill. 1914	.35
*Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties—W. B. Tucker, 1915	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties—Walter W. Bradley. 1915	.50
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties—F. L. Lowell. 1915	.25
Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties—Walter W. Bradley, G. C. Brown, F. L. Lowell and R. P. McLaughlin. 1915	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties—G. C. Brown. 1915	.50
Report XIV. Fletcher Hamilton, 1915, Biennial period 1913-1914. (The above county chapters combined in a single volume)	2.00

Chapters of State Mineralogist's Report, Biennial Period, 1915-1916, Fletcher Hamilton:

Mines and Mineral Resources, Alpine, Inyo and Mono Counties, with geological map—Arthur S. Eakle, Emile Huguenin, R. P. McLaughlin, Clarence A. Waring. 1917	1.25
Same as above, without geological map	.65
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties—W. Burling Tucker, Clarence A. Waring. 1917	.50
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties—W. Burling Tucker, Clarence A. Waring. 1917	.65
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties—Frederick J. H. Merrill. 1917	.50
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties—Walter W. Bradley, Emile Huguenin, C. A. Logan, Clarence A. Waring. 1917	.65
Mines and Mineral Resources, San Bernardino and Tulare Counties—H. C. Cloudman, Emile Huguenin, F. J. H. Merrill, W. Burling Tucker 1917	.65
Report XV. Fletcher Hamilton, 1918, Biennial period, 1915-1916. (The above county chapters combined in a single volume)	3.75

Chapters of the State Mineralogist's Report, Biennial Period 1917-1918. Fletcher Hamilton:

Mines and Mineral Resources of Nevada County—Errol MacBoyle. 1918	.75
Mines and Mineral Resources of Plumas County—Errol MacBoyle. 1918	.50
Mines and Mineral Resources of Sierra County—Errol MacBoyle. 1918	.50

BULLETINS.

*Bulletin	1.	Desiccated Human Remains.—Winslow Anderson. 1888	----
*Bulletin	2.	Methods of Mine Timbering.—W. H. Storms. 1894	----
*Bulletin	3.	Gas and Petroleum Yielding Formations of the Central Valley of California.—W. L. Watts. 1894	----
*Bulletin	4.	Catalogue of California Fossils (Parts 2, 3, 4 and 5).—J. G. Cooper. 1894	----
*Bulletin	5.	The Cyanide Process: Its Practical Application and Economical Results.—A. Scheidel. 1894	----

PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU—Continued.

Asterisk (*) indicates the publication is out of print.

		Price.
Bulletin	6. California Gold Mill Practices.—E. B. Preston. 1895	$0.50
*Bulletin	7. Mineral Production of California, by Counties, 1894.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	8. Mineral Production of California, by Counties, 1895.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	9. Mine Drainage, Pumps, etc.—Hans C. Behr. 1896	----
*Bulletin	10. A Bibliography Relating to the Geology, Palæontology, and Mineral Resources of California.—A. W. Vogdes. 1896	----
*Bulletin	11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties.—W. L. Watts. 1896	----
*Bulletin	12. Mineral Production of California, by Counties, 1896.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	13. Mineral Production of California, by Counties, 1897.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	14. Mineral Production of California, by Counties, 1898.—Chas. G. Yale. (Tabulated sheet)	----
Bulletin	15. Map of Oil City Oil Fields, Fresno County.—J. H. Means	----
*Bulletin	16. The Genesis of Petroleum and Asphaltum in California.—A. S. Cooper. 1899	----
*Bulletin	17. Mineral Production of California, by Counties, 1899.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	18. The Mother Lode Region of California.—W. H. Storms. 1900	----
*Bulletin	19. Oil and Gas Yielding Formations of California.—W. L. Watts. 1900	----
*Bulletin	20. Synopsis of General Report of State Mining Bureau.—W. L. Watts. 1900	----
*Bulletin	21. Mineral Production of California, by Counties, 1900.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	22. Mineral Production of California for Fourteen Years.—Chas. G. Yale. 1900. (Tabulated sheet)	----
Bulletin	Reconnaissance of the Colorado Desert Mining District.—Stephen Bowers. 1901	----
Bulletin	23. The Copper Resources of California.—P. C. DuBois, F. M. Anderson, J. H. Tibbits, and G. A. Tweedy. 1902	$0.50
*Bulletin	24. The Saline Deposits of California.—G. E. Bailey. 1902	----
*Bulletin	25. Mineral Production of California, by Counties, 1901.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	26. Mineral Production of California for Fifteen Years.—Chas. G. Yale. 1901. (Tabulated sheet)	----
*Bulletin	27. The Quicksilver Resources of California.—Wm. Forstner. 1903	----
*Bulletin	28. Mineral Production of California, by Counties, 1902.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	29. Mineral Production of California for Sixteen Years.—Chas. G. Yale. 1902. (Tabulated sheet)	----
*Bulletin	30. A Bibliography of Geology, Palæontology, and Mineral Resources of California.—A. W. Vogdes. 1903	----
*Bulletin	31. Chemical Analyses of California Petroleum.—H. N. Cooper. 1903. (Tabulated sheet)	----
*Bulletin	32. Production and Use of Petroleum in California.—P. W. Prutzman. 1904	.25
*Bulletin	33. Mineral Production of California, by Counties, 1903.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	34. Mineral Production of California for Seventeen Years.—Chas. G. Yale. 1903. (Tabulated Sheet)	----
*Bulletin	35. Mines and Minerals of California, for 1903.—Chas. G. Yale. 1904. (Statistical)	----
*Bulletin	36. Gold Dredging in California.—J. E. Doolittle. 1905	----
Bulletin	37. Gems, Jewelers' Materials, and Ornamental Stones of California. —George F. Kunz. 1905:	
	First edition (without colored plates)	.25
	*Second edition (with colored plates)	----
*Bulletin	38. The Structural and Industrial Materials of California.—Wm. Forstner, T. C. Hopkins, C. Naramore, L. H. Eddy. 1906	----
*Bulletin	39. Mineral Production of California, by Counties, 1904.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	40. Mineral Production of California for Eighteen Years.—Chas. G. Yale. 1904. (Tabulated sheet)	----
*Bulletin	41. Mines and Minerals of California, for 1904.—Chas. G. Yale. (Statistical)	----
*Bulletin	42. Mineral Production of California, by Counties. 1905.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	43. Mineral Production of California for Nineteen Years.—Chas. G. Yale. 1905. (Tabulated sheet)	----
*Bulletin	44. Mines and Minerals of California, for 1905.—Chas. G. Yale. (Statistical)	----
*Bulletin	45. Auriferous Black Sands of California.—J. A. Edman. 1907	----
Bulletin	46. General Index to Publications of the State Mining Bureau.—Compiled by Chas. G. Yale. 1907	.30
*Bulletin	47. Mineral Production of California, by Counties, 1906.—Chas. G. Yale. (Tabulated sheet)	----
*Bulletin	48. Mineral Production of California for Twenty Years.—Chas. G. Yale. 1906. (Tabulated sheet)	----

PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU—Continued.

Asterisk (*) indicates the publication is out of print.

		Price.
*Bulletin 49.	Mines and Minerals of California, for 1906.—Chas. G. Yale. (Statistical)	----
Bulletin 50.	The Copper Resources of California.—A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne, J. A. Edman. 1908	$1.00
*Bulletin 51.	Mineral Production of California, by Counties, 1907.—D. H. Walker. (Tabulated sheet)	----
*Bulletin 52.	Mineral Production of California for Twenty-one Years.—D. H. Walker. 1907. (Tabulated sheet)	----
*Bulletin 53.	Mineral Production of California for 1907, with County Maps—D. H. Walker. 1908. (Statistical)	----
*Bulletin 54.	Mineral Production of California, by Counties, 1908.—D. H. Walker. (Tabulated sheet)	----
*Bulletin 55.	Mineral Production of California for Twenty-two years.—D. H. Walker. 1908. (Tabulated sheet)	----
*Bulletin 56.	Mineral Production for 1908, County Maps, and Mining Laws of California.—D. H. Walker. 1909. (Statistical)	----
*Bulletin 57.	Gold Dredging in California.—W. B. Winston, Charles Janin. 1910	----
*Bulletin 58.	Mineral Production of California, by Counties, 1909.—D. H. Walker. (Tabulated sheet)	----
*Bulletin 59.	Mineral Production of California for Twenty-three Years.—D. H. Walker. 1909. (Tabulated sheet)	----
*Bulletin 60.	Mineral Production for 1909, County Maps, and Mining Laws of California.—D. H. Walker. 1910. (Statistical)	----
*Bulletin 61.	Mineral Production of California, by Counties, for 1910.—D. H. Walker. (Tabulated sheet)	----
*Bulletin 62.	Mineral Production of California for Twenty-four Years.—D. H. Walker. 1910. (Tabulated sheet)	----
Bulletin 63.	Petroleum in Southern California.—P. W. Prutzman. 1912	.75
*Bulletin 64.	Mineral Production for 1911.—E. S. Boalich, Statistician. 1912	----
*Bulletin 65.	Mineral Production for 1912.—E. S. Boalich. 1913	----
*Bulletin 66.	Mining Laws (United States and California). 1914	----
*Bulletin 67.	Minerals of California.—A. S. Eakle. 1914	----
*Bulletin 68.	Mineral Production for 1913.—E. S. Boalich. 1914	----
*Bulletin 69.	Petroleum Industry of California with Folio of Maps (18x22 in.)—R. P. McLaughlin and C. A. Waring. 1914	2.00
*Bulletin 70.	Mineral Production for 1914, with Mining Law Appendix. 1915.	----
*Bulletin 71.	California Mineral Production for 1915, with Mining Law Appendix and Maps.—Walter W. Bradley. 1916	----
Bulletin 72.	Geologic Formations of California.—James Perrin Smith. 1917. (For Map, see below)	.25
*Bulletin 73.	Report of Operations of Department of Petroleum and Gas for 1915-1916.—R. P. McLaughlin. 1917	----
Bulletin 74.	California Mineral Production for 1916, with County Maps.—Walter W. Bradley. 1917	----
Bulletin 75.	Mining Laws, United States and California. 1917	----
Bulletin 76.	Manganese and Chromium in California.—Walter W. Bradley, Emile Huguenin, C. A. Logan, W. Burling Tucker, C. A. Waring. 1918	.50
Bulletin 77.	Catalogue of the Publications of the California State Mining Bureau, 1880-1917.—E. S. Boalich. 1918	----
Bulletin 78.	Quicksilver Resources of California.—Walter W. Bradley. 1918	1.50
Bulletin 79.	Magnesite in California. (In press)	----
Bulletin 80.	Tungsten, Molybdenum and Vanadium in California. (In preparation)	----
Bulletin 81.	Copper Resources of Foothill Belt, California. (In preparation)	----
Bulletin 82.	Second Annual Report of the State Oil and Gas Supervisor, 1916-1917.—R. P. McLaughlin. 1918	----
Bulletin 83.	California Mineral Production for 1917, with County Maps.—Walter W. Bradley. 1918	----
Bulletin 84.	Third Annual Report of the State Oil and Gas Supervisor, 1917-1918.—R. P. McLaughlin. 1919	----
Bulletin 85.	Platinum Resources of California	.50
Bulletin 86.	California Mineral Production for 1918, with County Maps.—Walter W. Bradley. 1919	----
Bulletin 87.	Commercial Minerals of California.—W. O. Castello. (In press)	----
Bulletin 88.	California Mineral Production for 1919, with County Maps.—Walter W. Bradley. 1920	----

PRELIMINARY REPORTS.

*Preliminary Report No. 1.	Notes on Damage by Water in California Oil Fields, Dec., 1913. By R. P. McLaughlin
*Preliminary Report No. 2.	Notes on Damage by Water in California Oil Fields, Mar., 1914. By R. P. McLaughlin
*Preliminary Report No. 3.	Manganese and Chromium, 1917. By E. S. Boalich
Preliminary Report No. 3.	Manganese and Chromium. By E. S. Boalich. (Second edition)
Preliminary Report No. 4.	Tungsten, Molybdenum and Vanadium, 1918. By E. S. Boalich and W. O. Castello
Preliminary Report No. 5.	Antimony, Graphite, Nickel, Potash, Strontium, Tin, 1918. By E. S. Boalich and W. O. Castello
Preliminary Report No. 6.	Review of Mining in California during 1919
Preliminary Report No. 7.	Clay Industry of California

PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU—Continued.

REGISTERS OF MINES WITH MAPS.

Asterisk (*) indicates the publication is out of print.

	Price
Amador County	$.25
Butte County	.25
*Calaveras County	----
*El Dorado County	----
*Inyo County	----
*Kern County	----
*Lake County	----
*Mariposa County	----
*Nevada County	----
*Placer County	----
*Plumas County	----
*San Bernardino County	----
*San Diego County	----
Santa Barbara County	.25
*Shasta County	----
*Sierra County	----
*Siskiyou County	----
*Trinity County	----
*Tuolumne County	----
Yuba County	.25
Register of Oil Wells (with map), Los Angeles City	.35

OTHER MAPS.

*California, Showing Mineral Deposits (50x60 in.)—mounted	----
Forest Reserves in California—	
Mounted	.50
Unmounted	.30
*Mineral and Relief Map of California	----
El Dorado County, Showing Boundaries of National Forests	.20
Madera County, Showing Boundaries of National Forests	.20
Placer County, Showing Boundaries of National Forests	.20
Shasta County, Showing Boundaries of National Forests	.20
Sierra County, Showing Boundaries of National Forests	.20
Siskiyou County, Showing Boundaries of National Forests	.20
*Trinity County, Showing Boundaries of National Forests	----
Tuolumne County, Showing Boundaries of National Forests	.20
*Mother Lode Region	----
Desert Region of Southern California	.10
Minaret Region, Madera County	.20
Copper Deposits in California	.05
Calaveras County	.25
Lake County	.25
Tuolumne County	.25
Geological Map of California (mounted)—50x60 inches	2.50
Geological Map of Inyo County	.60

OIL FIELDS MAPS.

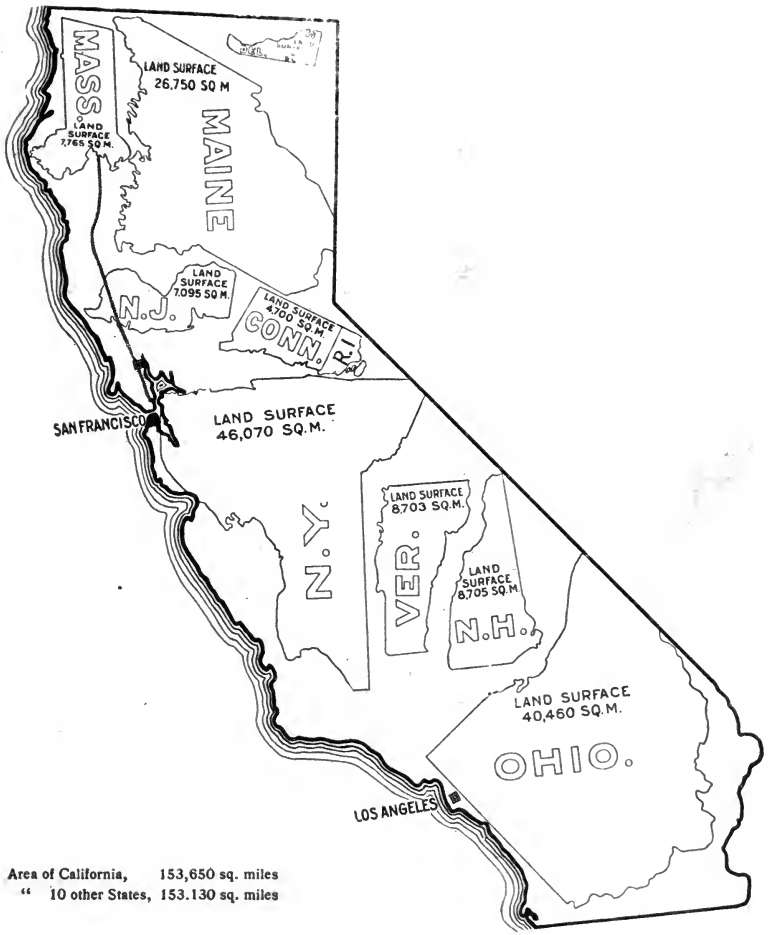
The following maps of the oil fields of the state have been completed and placed on sale:

The prices of the maps are 75 cents per copy, with the exception of the Sargent oil map, which is 50 cents. These prices include postage.

Map No. 1—Sargent, Santa Clara County.
Map No. 2—Santa Maria, including Cat Cañon and Los Alamos.
Map No. 3—Santa Maria, including Casmalia and Lompoc.
Map No. 4—Whittier-Fullerton, including Olinda, Brea Cañon, Puente Hills, East Coyote, and Richfield.
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote, and Montebello.
Map No. 6—Salt Lake, Los Angeles County.
Map No. 7—Sunset and San Emidio, Kern County.
Map No. 8—South Midway and Buena Vista Hills, Kern County.
Map No. 9—North Midway and McKittrick, Kern County.
Map No. 10—Belridge and McKittrick Front, Kern County.
Map No. 11—Lost Hills and North Belridge, Kern County.
Map No. 12—Devils Den, Kern County.
Map No. 13—Kern River, Kern County.
Map No. 14—Coalinga, Fresno County.
Map No. 15—Elk Hills, Kern County.
Map No. 16—Ventura-Ojai, Ventura County.
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County.
Map No. 18—(In preparation).
Map No. 19—Arroyo Grande, San Luis Obispo County.

DETERMINATION OF MINERAL SAMPLES.

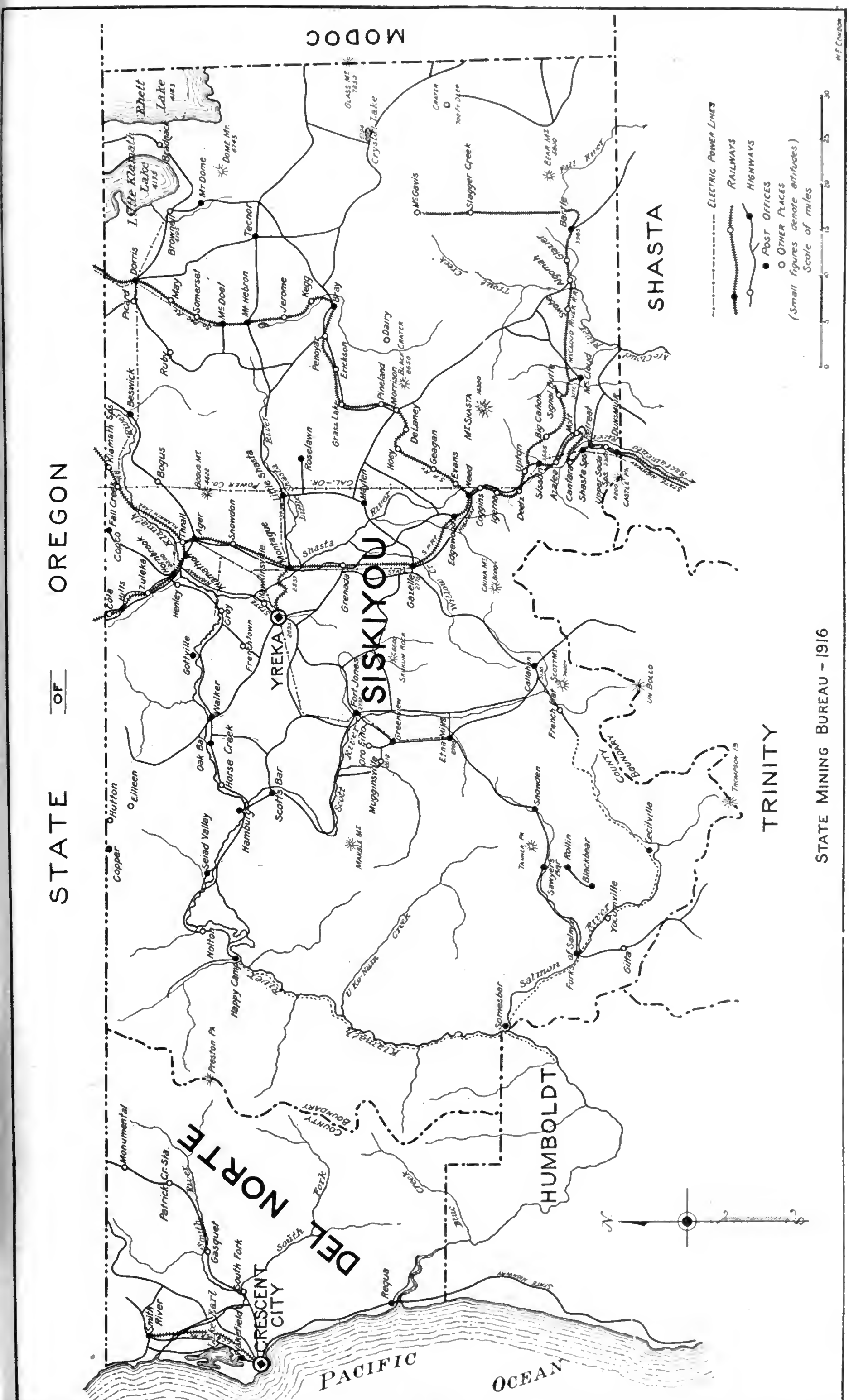
Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.



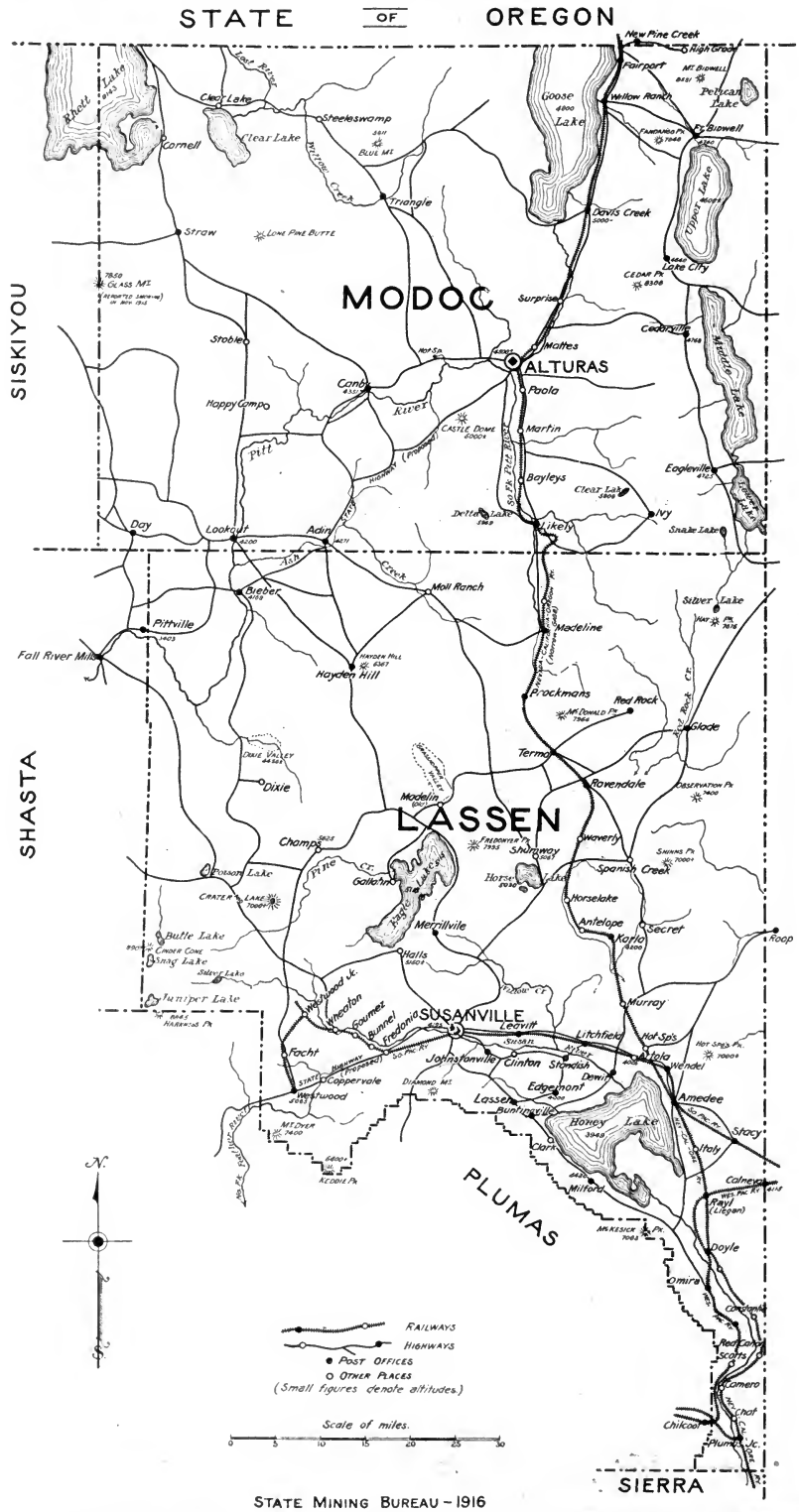
Outline map of California, showing relative areas of ten other states.

The following county maps show all towns, post offices, railroads, stage lines, and the highways. They are especially valuable to all who wish to leave the railroad and penetrate to the interior of the mining districts of the state. These maps must not be reproduced without obtaining permission from the Mining Bureau.

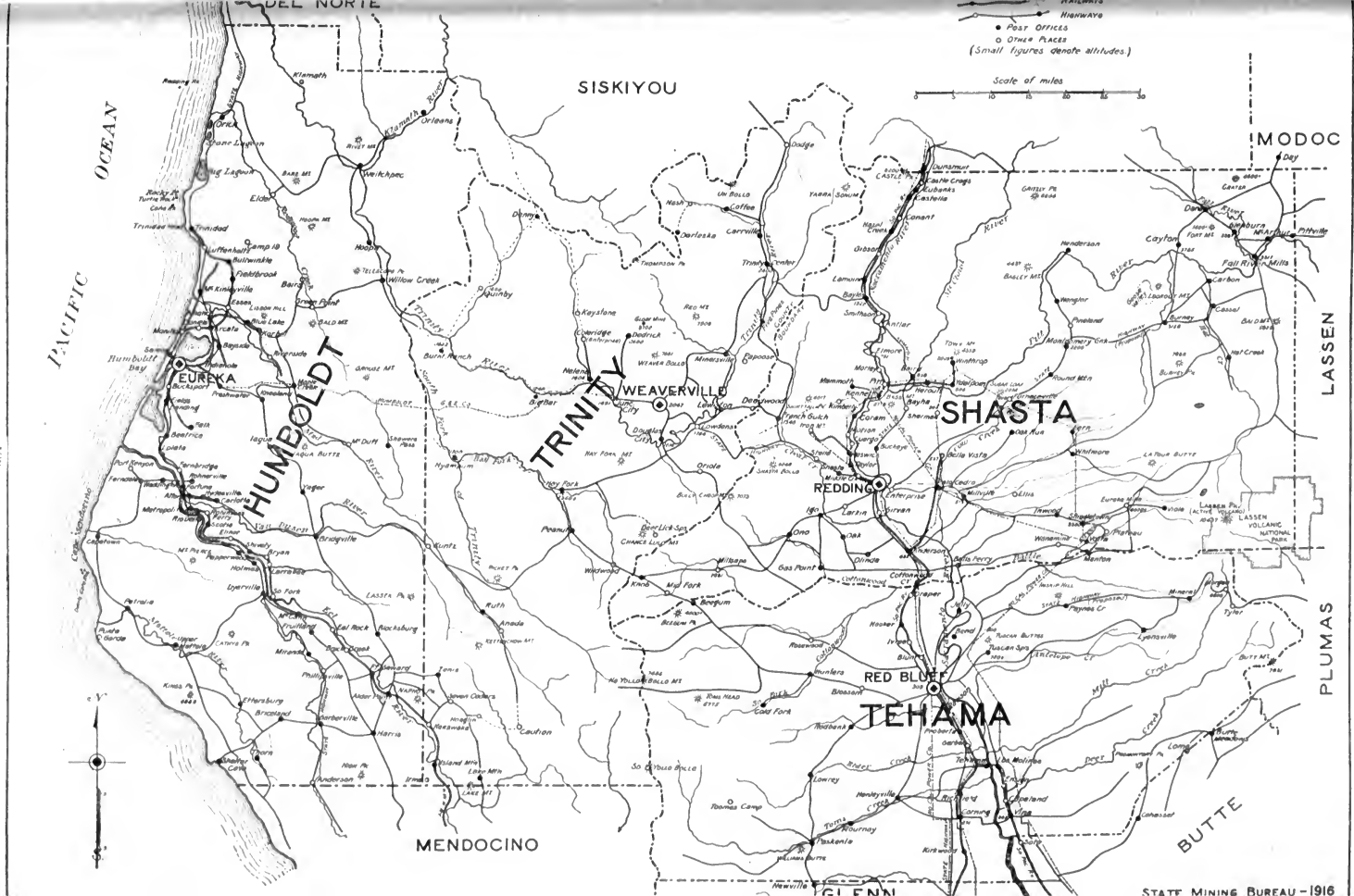

RELIEF MAP OF
CALIFORNI
Issued by the
CALIFORNIA STATE MINING BURE
FLETCHER HAMILTON
State Mineralogist
PACIFIC OCEAN

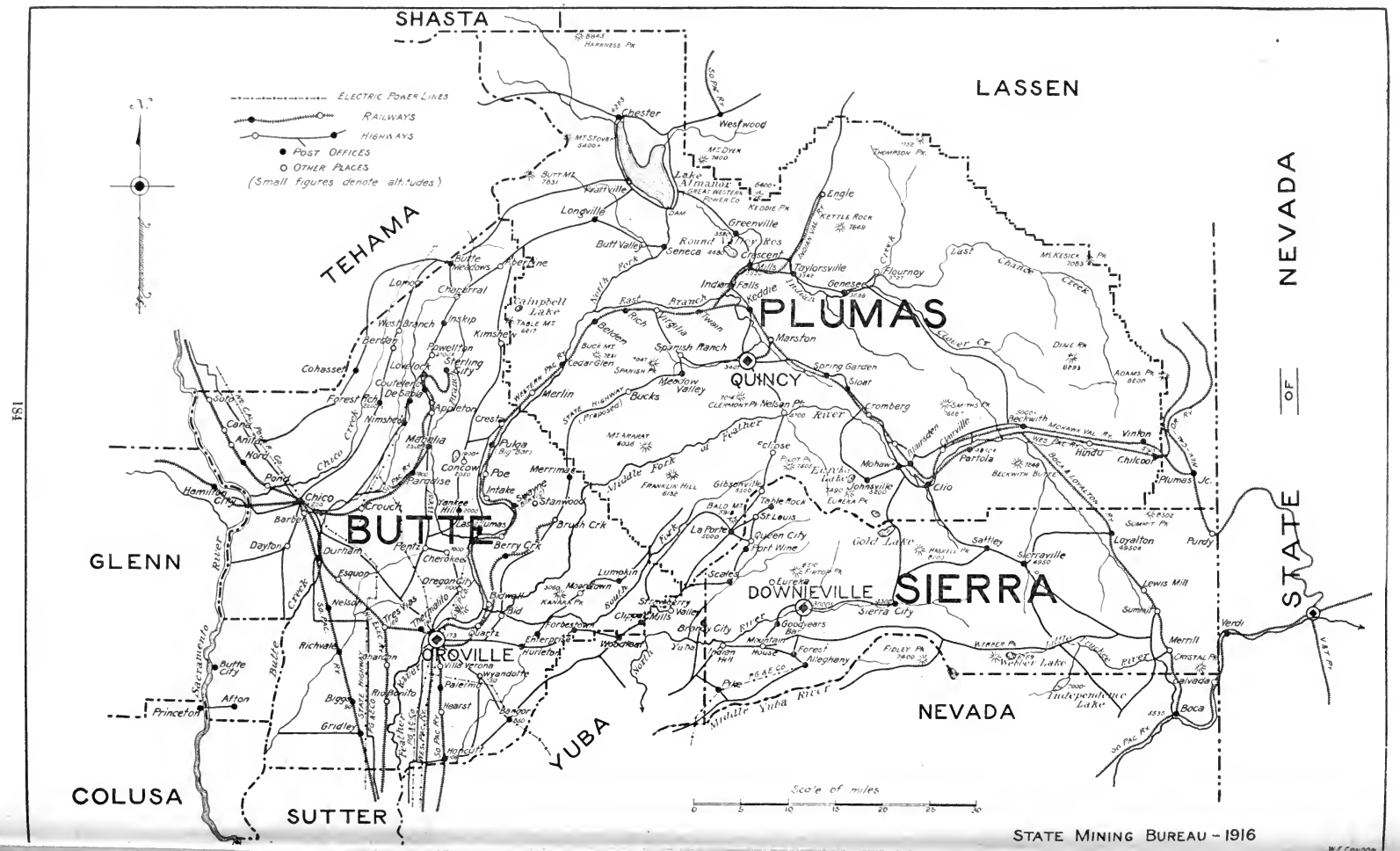


STATE OF OREGON
MODOC
SISKIYOU
DEL NORTE
HUMBOLDT
TRINITY
SHASTA
PACIFIC OCEAN
YREKA
CRESCENT CITY
STATE MINING BUREAU - 1916
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
COUNTY BOUNDARY
CAL.-OR. POWER CO.
Klamath River
Scott River
Salmon River
Shasta River
Mt. Shasta
Dunsmuir
Weed
Etna Mills
Fort Jones
Happy Camp
Requa
Somesbar
Forks of Salmon

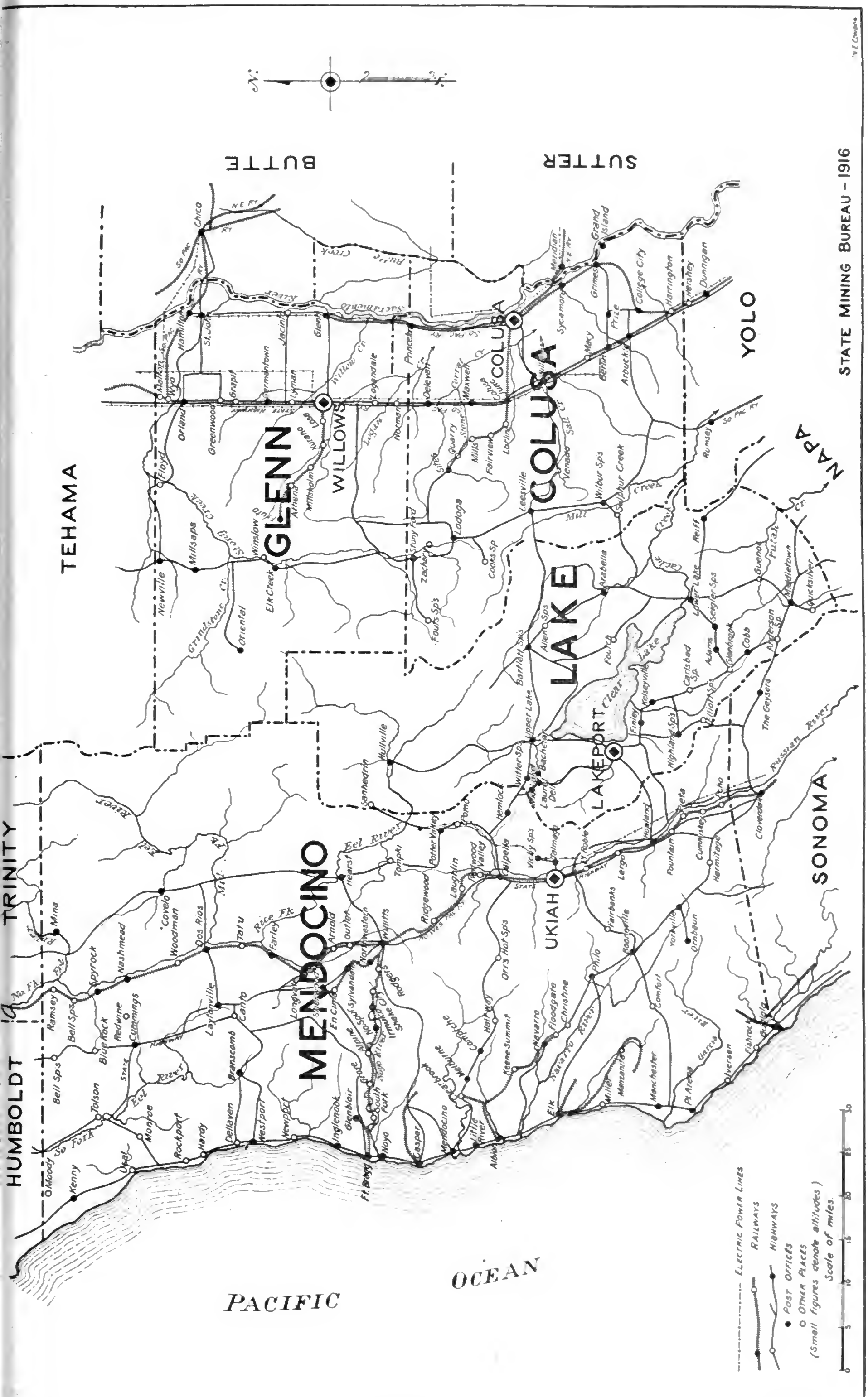


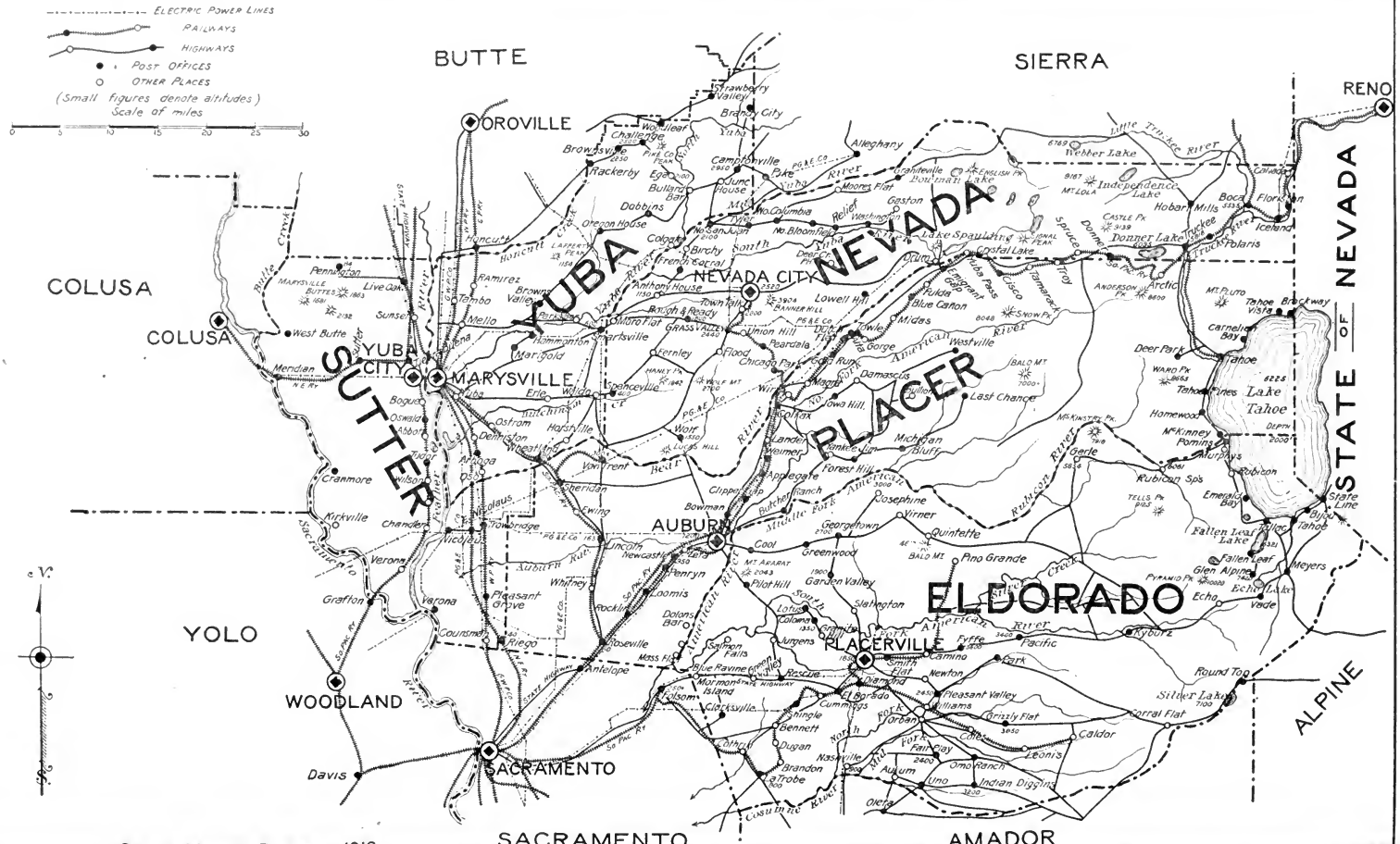
STATE MINING BUREAU - 1916


DEL NORTE
SISKIYOU
MODOC
LASSEN
PLUMAS
BUTTE
GLENN
MENDOCINO
TEHAMA
RED BLUFF
REDDING
SHASTA
WEAVERVILLE
TRINITY
HUMBOLDT
EUREKA
PACIFIC OCEAN
Humboldt Bay
Railways
Highways
Post Offices
Other Places
(Small figures denote altitudes.)
Scale of miles
LASSEN VOLCANIC NATIONAL PARK
STATE MINING BUREAU - 1916

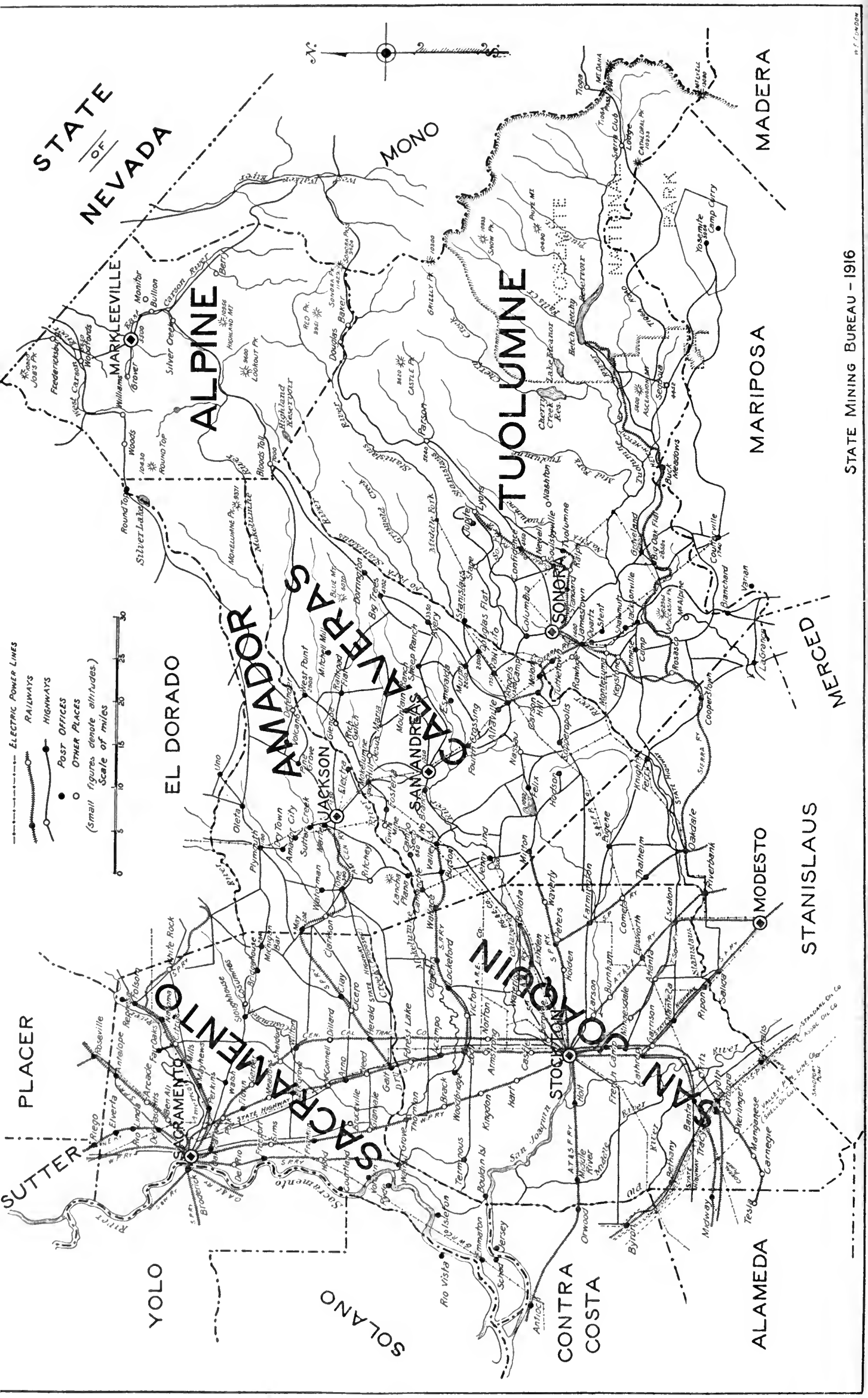


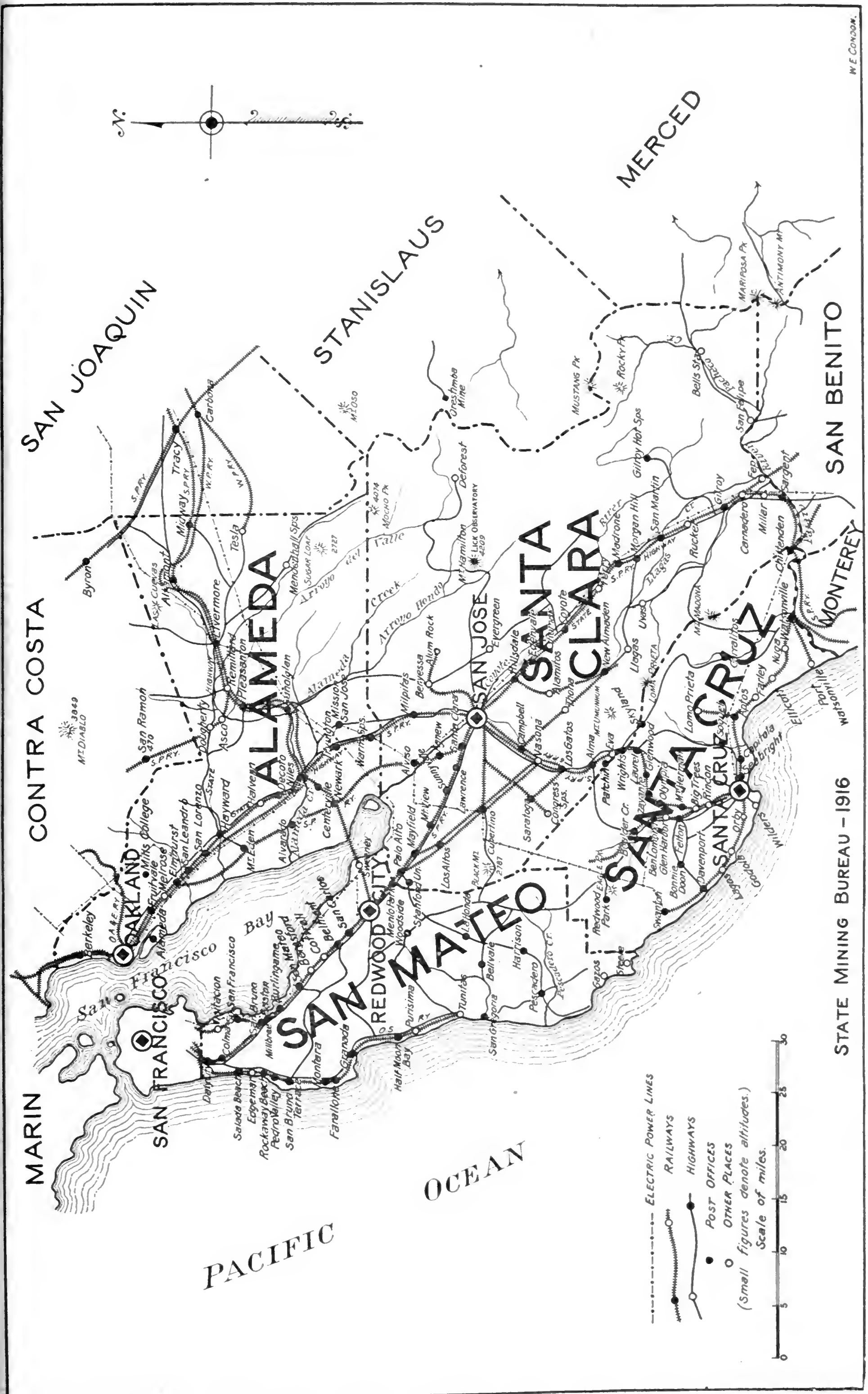
STATE MINING BUREAU - 1916


HUMBOLDT
TRINITY
TEHAMA
BUTTE
SUTTER
GLENN
COLUSA
LAKE
MENDOCINO
YOLO
NAPA
SONOMA
PACIFIC
OCEAN
WILLOWS
COLUSA
LAKEPORT
UKIAH
Clear Lake
Eel River
Russian River
Sacramento River
Chico
Orland
Ft. Bragg
Mendocino
Covelo
Willits
Hopland
Cloverdale
Electric Power Lines
Railways
Highways
Post Offices
Other Places
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU - 1916

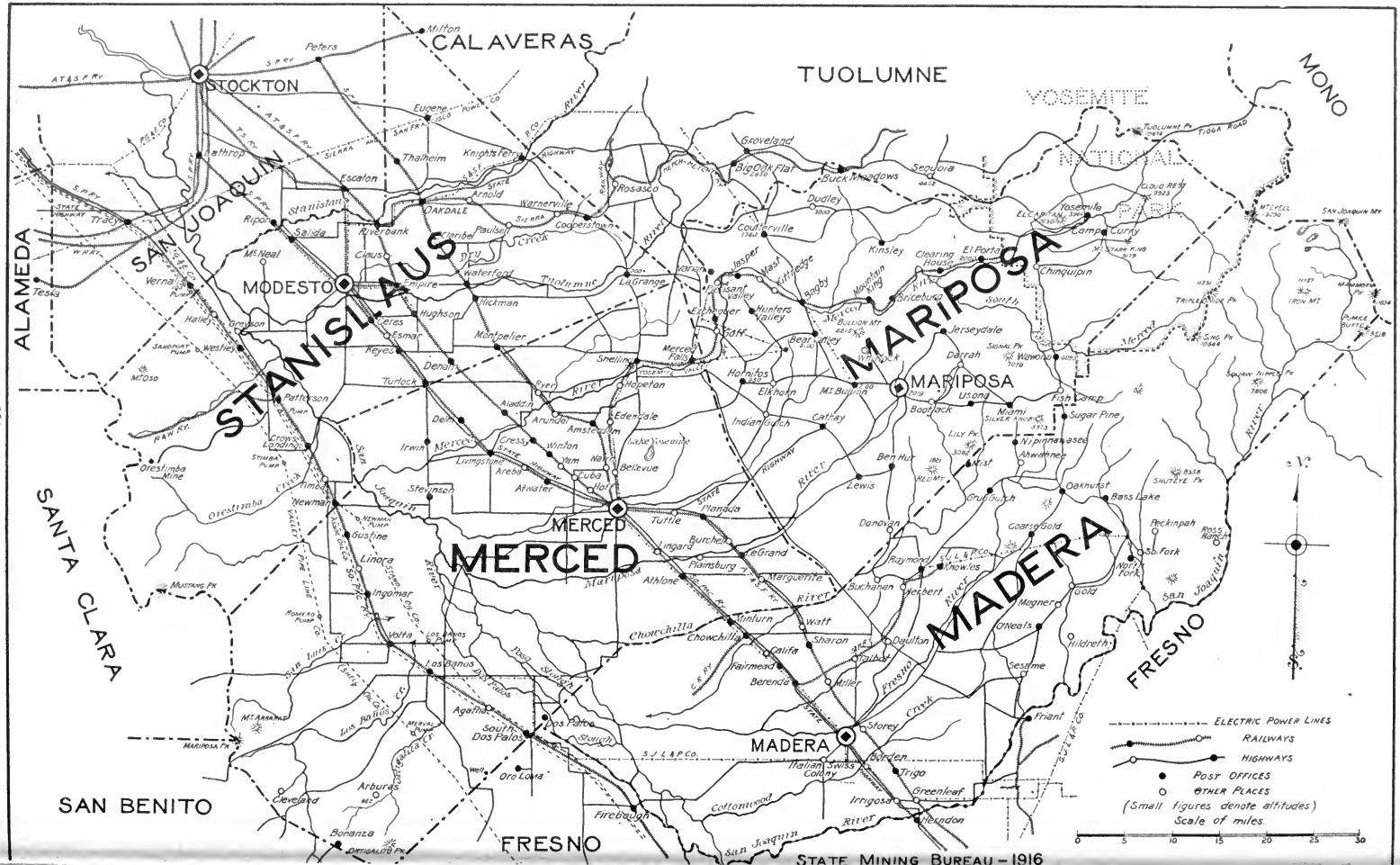

ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30
BUTTE
SIERRA
RENO
OROVILLE
COLUSA
YUBA
NEVADA
NEVADA CITY
SUTTER
YUBA CITY
MARYSVILLE
PLACER
AUBURN
ELDORADO
PLACERVILLE
YOLO
WOODLAND
SACRAMENTO
Davis
ALPINE
STATE OF NEVADA
Lake Tahoe
SACRAMENTO
AMADOR
STATE MINING BUREAU - 1916


MENDOCINO
LAKE
COLUSA
SUTTER
YOLO
WOODLAND
SACRAMENTO
SONOMA
NAPA
SANTA ROSA
NAPA
SOLANO
FAIRFIELD
MARIN
SAN RAFAEL
MARTINEZ
CONTRA COSTA
OAKLAND
SAN FRANCISCO
ALAMEDA
SAN JOAQUIN
STOCKTON
PACIFIC
OCEAN
SACRAMENTO
San Pablo Bay
Suisun Bay
FARALLONE ISLANDS
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
Scale of miles
0 5 10 15 20 25 30
STATE MINING BUREAU - 1916

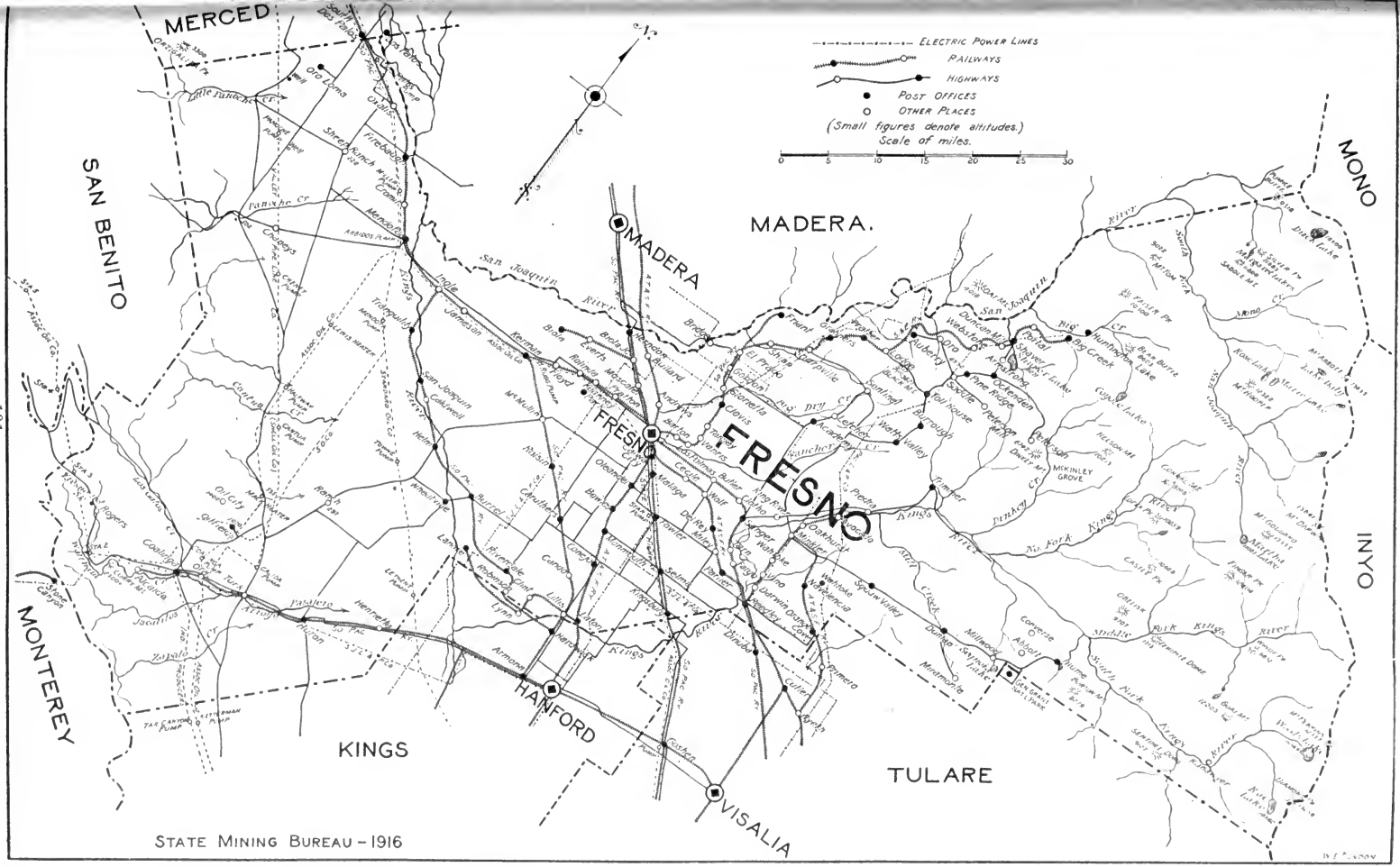

STATE OF NEVADA
MONO
ALPINE
AMADOR
CALAVERAS
TUOLUMNE
EL DORADO
PLACER
SUTTER
YOLO
SOLANO
SACRAMENTO
SAN JOAQUIN
CONTRA COSTA
ALAMEDA
STANISLAUS
MERCED
MARIPOSA
MADERA
YOSEMITE NATIONAL PARK
MARKLEEVILLE
JACKSON
SAN ANDREAS
SONORA
SACRAMENTO
STOCKTON
MODESTO
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0
5
10
15
20
25
30
STATE MINING BUREAU - 1916

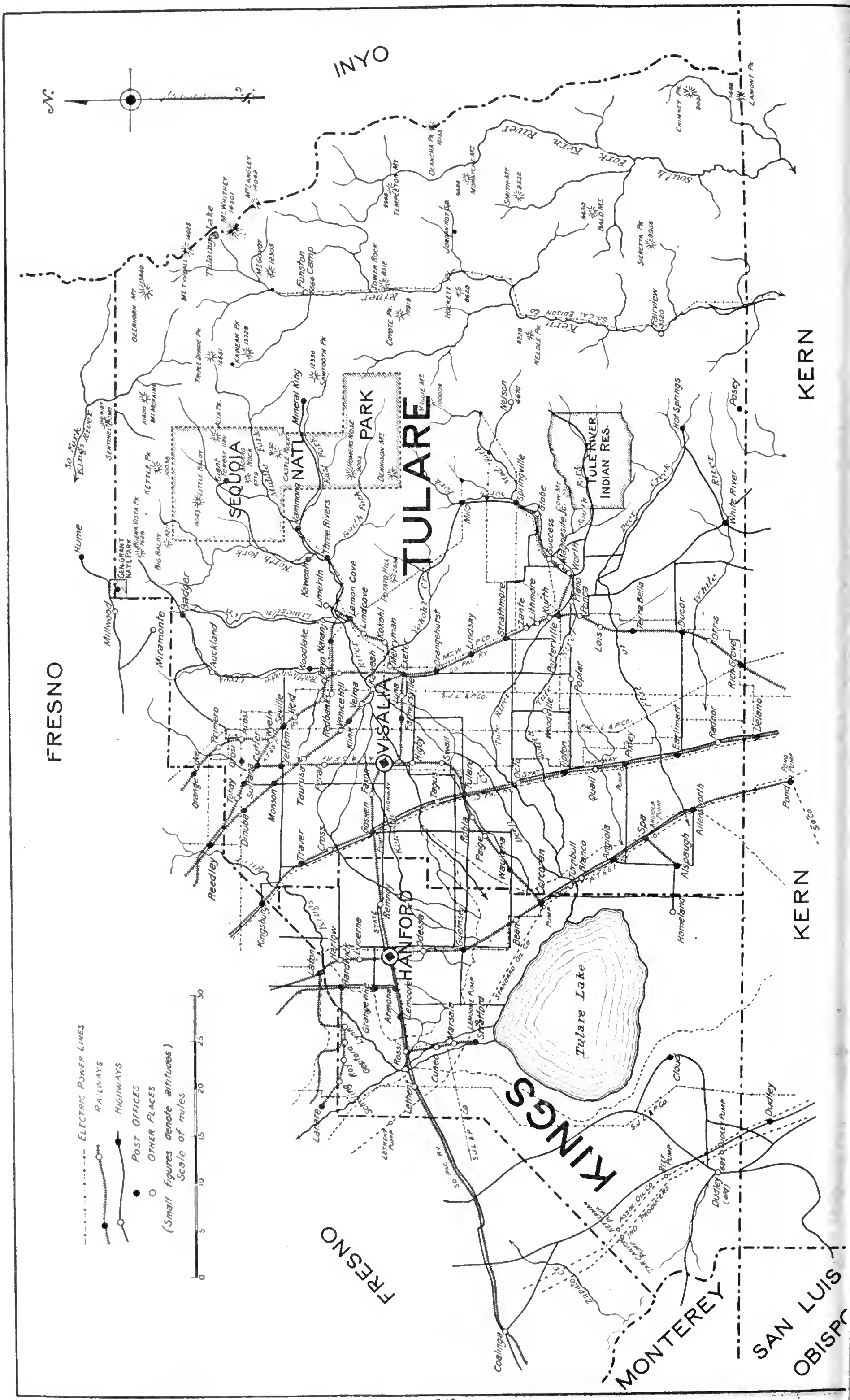


SAN JOAQUIN
STANISLAUS
MERCED
CONTRA COSTA
ALAMEDA
SANTA CLARA
SAN BENITO
MONTEREY
SANTA CRUZ
SAN MATEO
SAN FRANCISCO
MARIN
PACIFIC
OCEAN
San Francisco Bay
OAKLAND
SAN JOSE
REDWOOD CITY
SANTA CRUZ
N.
S.
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
Scale of miles.
0
5
10
15
20
25
30
STATE MINING BUREAU – 1916
W. E. CONDON.

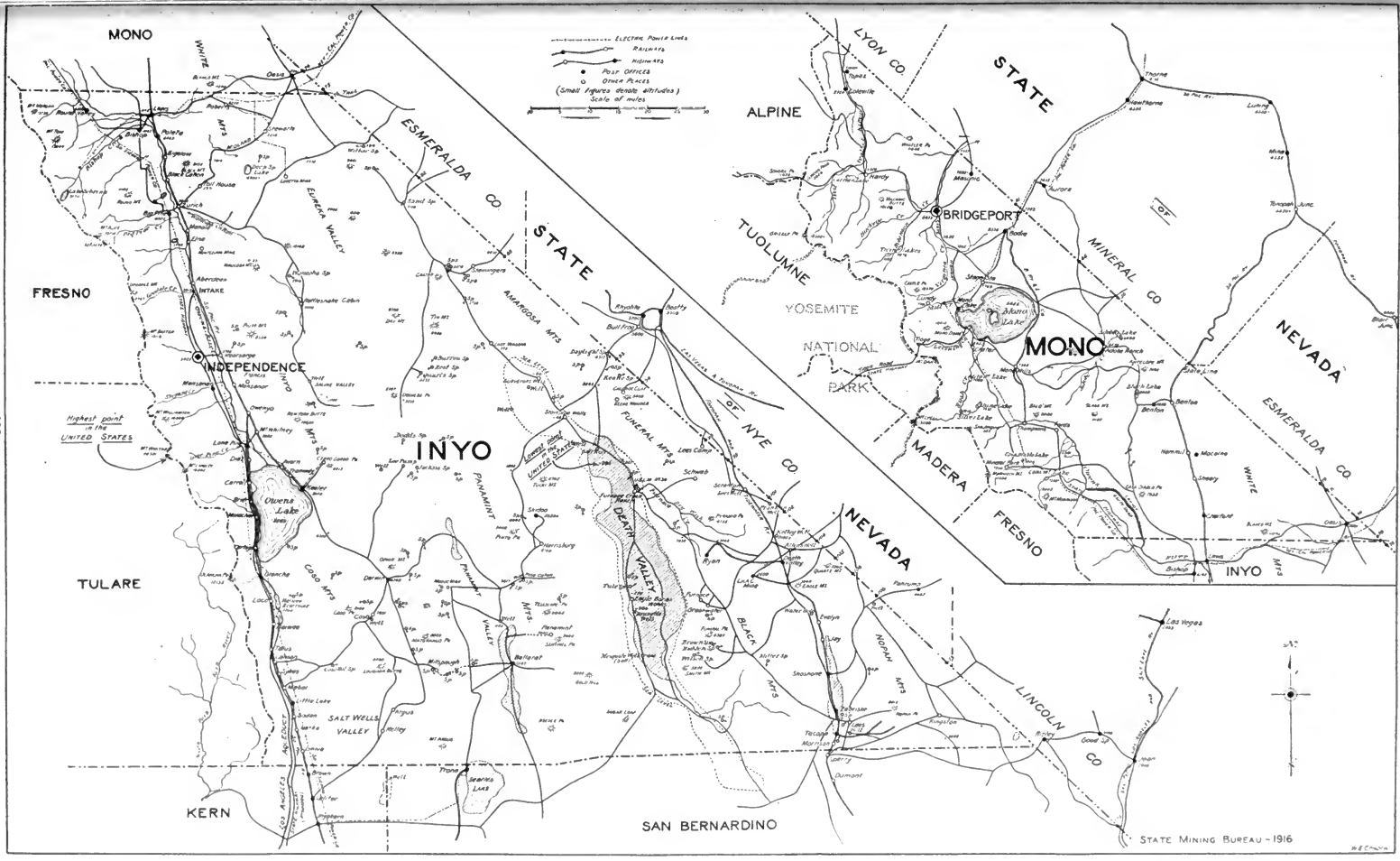


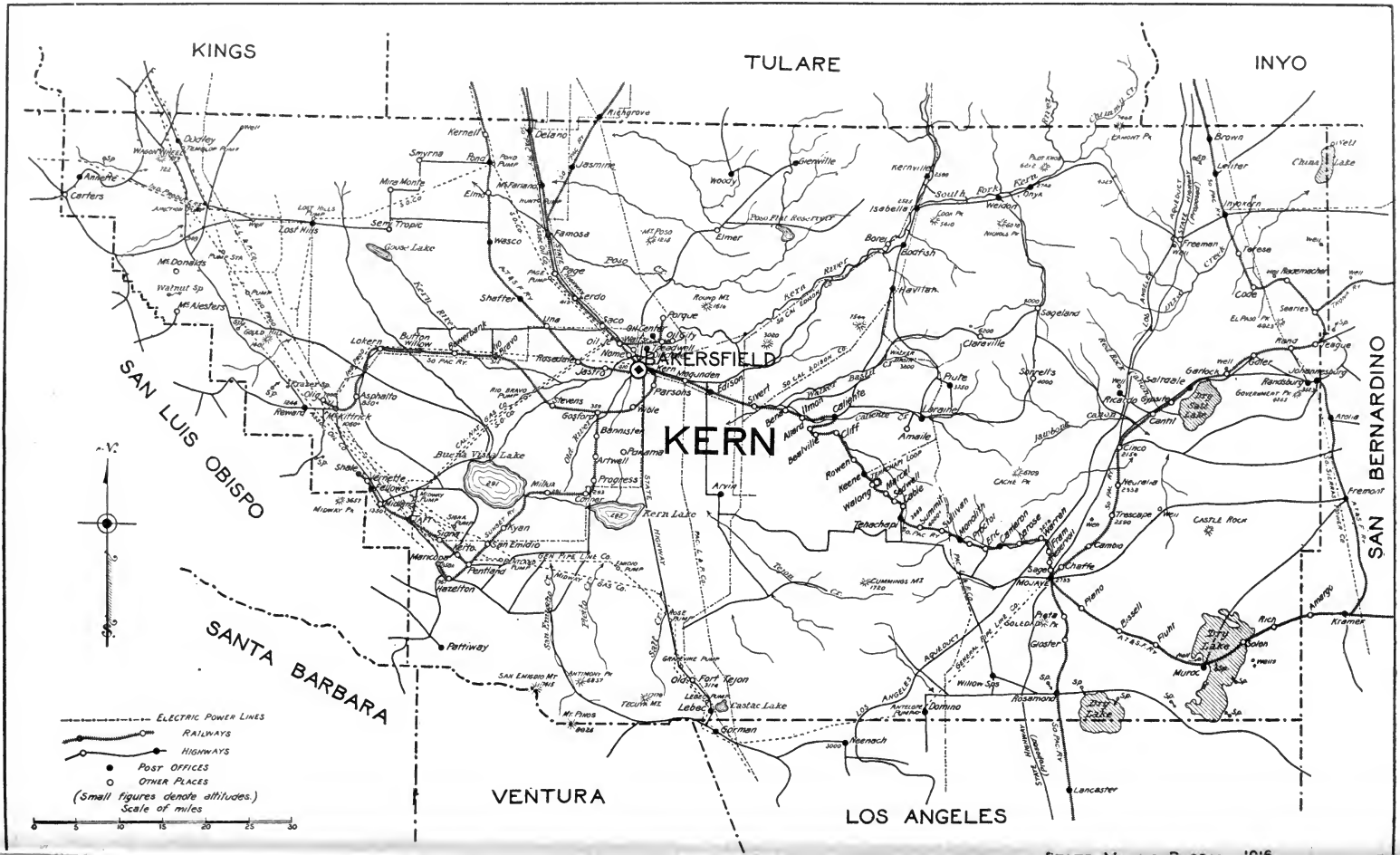
STATE MINING BUREAU – 1916

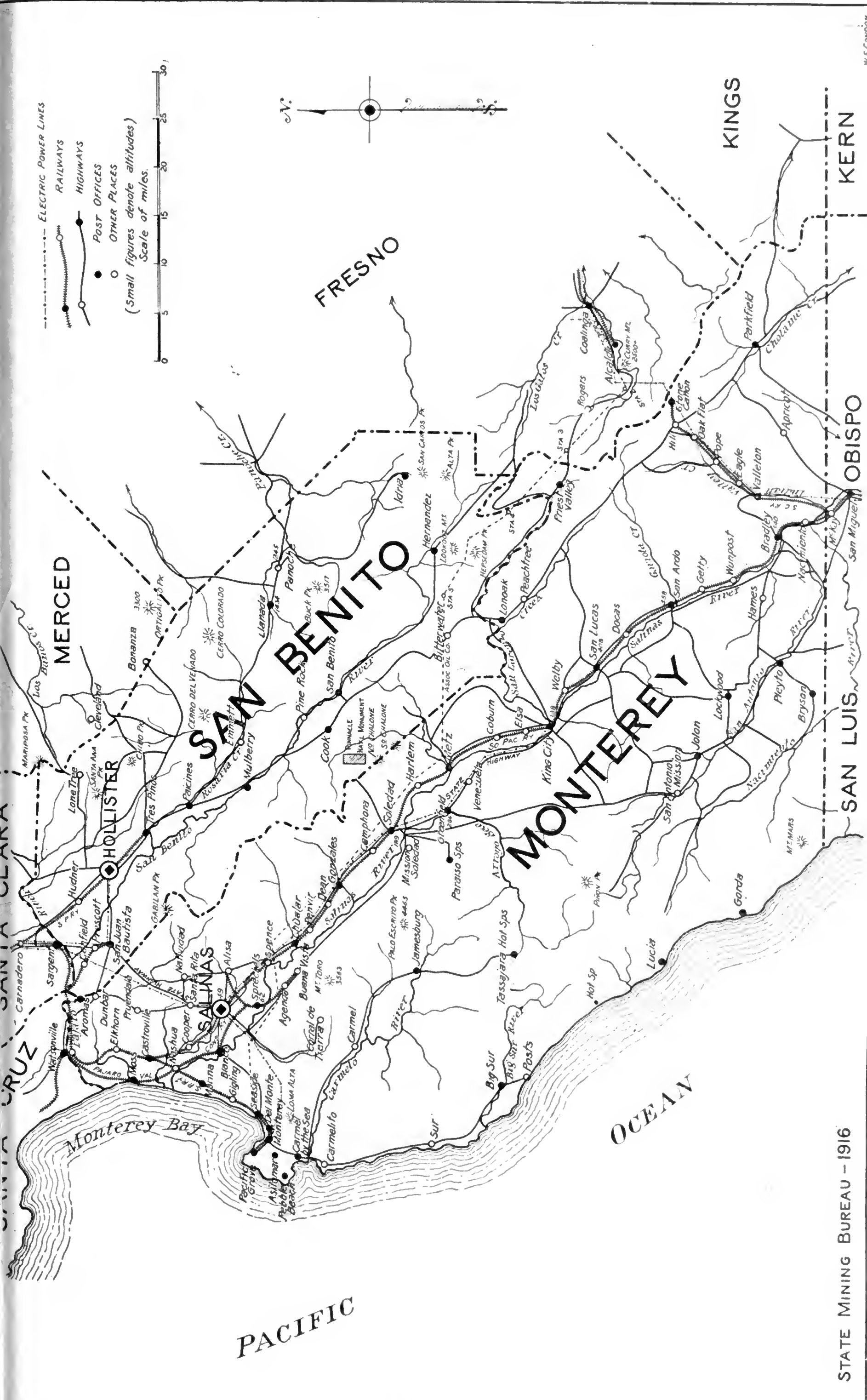

ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
Scale of miles.
0 5 10 15 20 25 30
MERCED
SAN BENITO
MONTEREY
MADERA
MADERA.
FRESNO
FRESNO
MONO
INYO
KINGS
HANFORD
VISALIA
TULARE
STATE MINING BUREAU - 1916



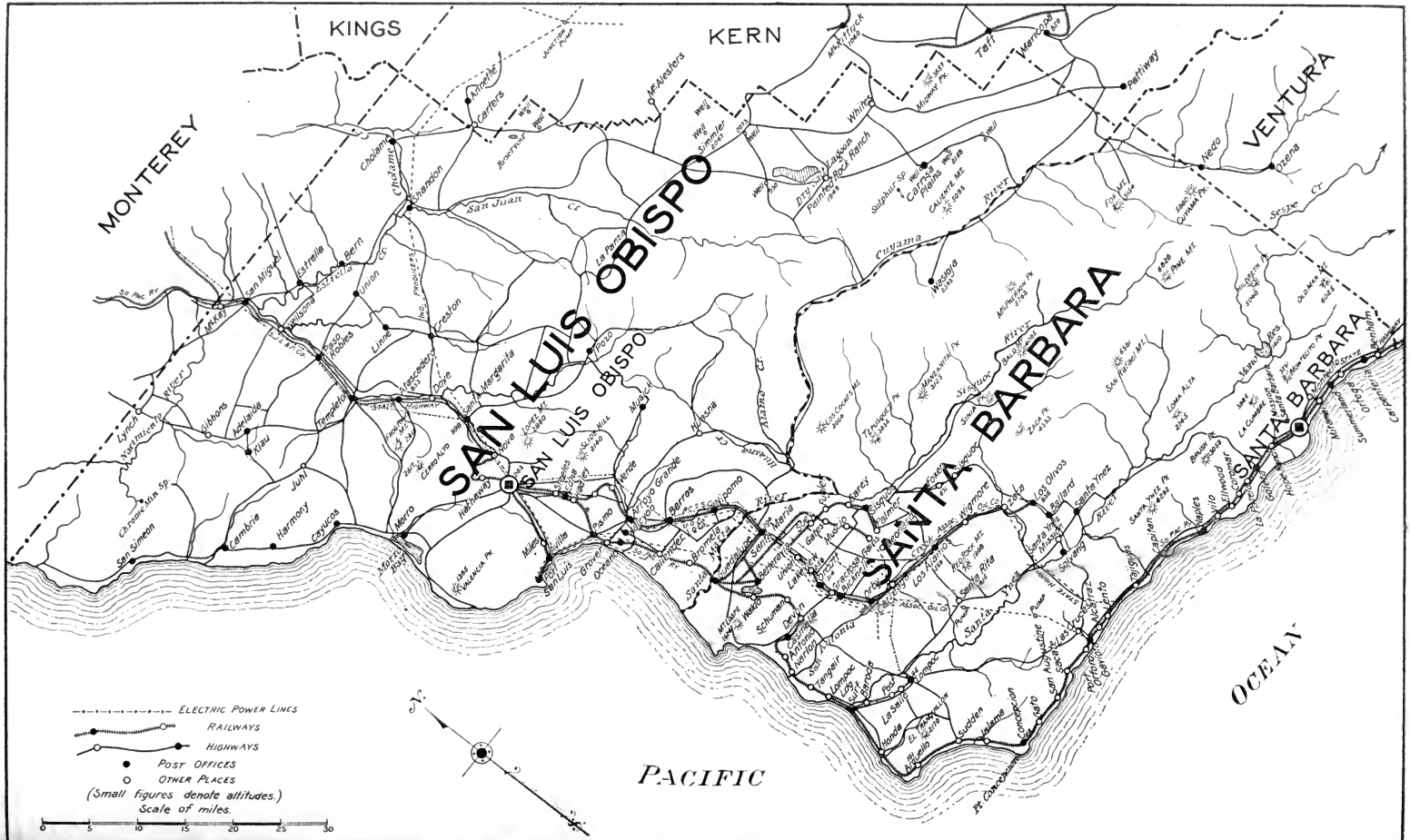
INYO
FRESNO
TULARE
KINGS
KERN
KERN
FRESNO
MONTEREY
SAN LUIS OBISPO
SEQUOIA NAT'L PARK
TULE RIVER INDIAN RES.
GEN. GRANT NAT'L PARK
Tulare Lake
VISALIA
HANFORD
Electric Power Lines
Railways
Highways
Post Offices
Other Places
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30

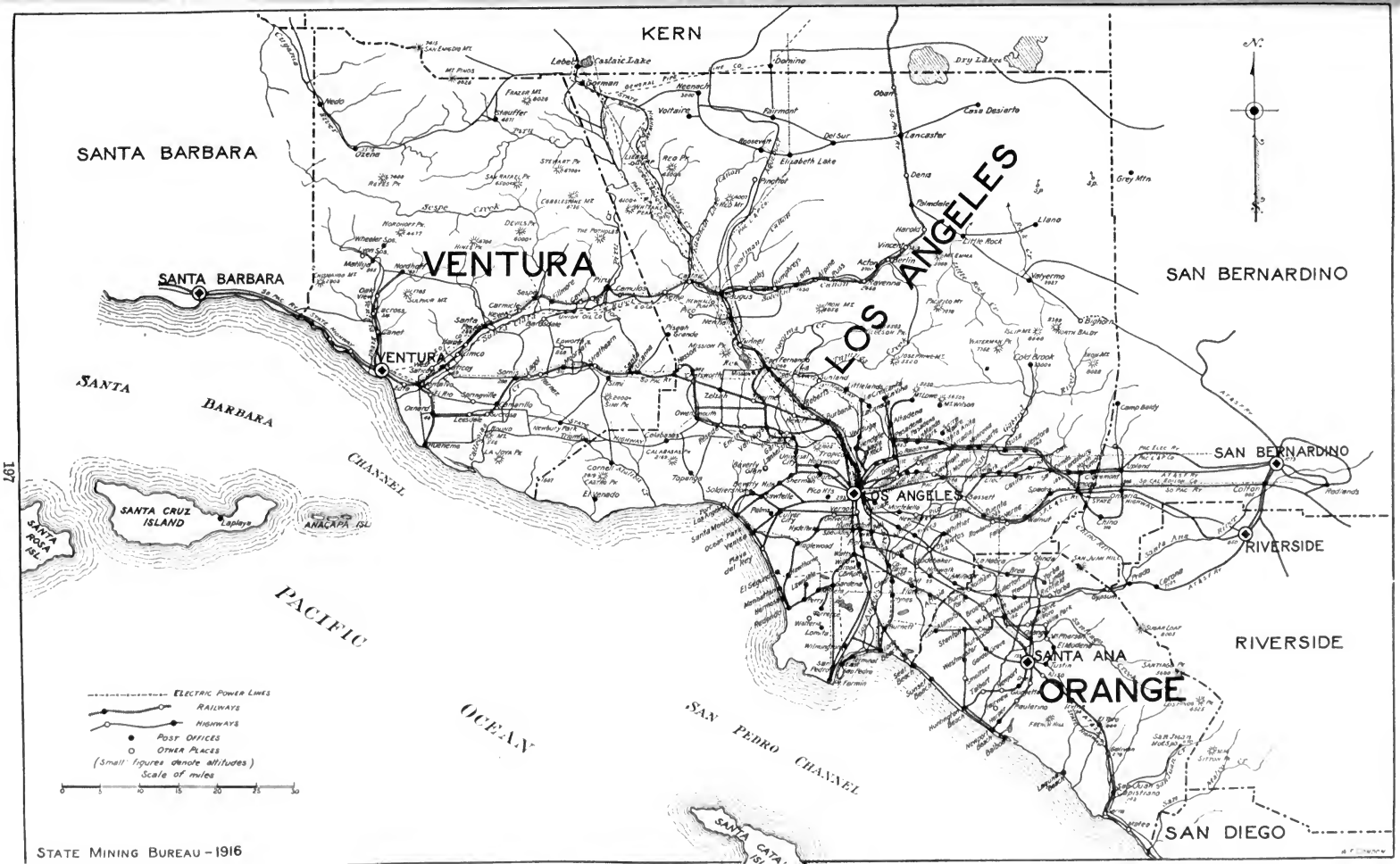

MONO
WHITE
ESMERALDA CO
STATE OF NEVADA
ALPINE
LYON CO
TUOLUMNE
YOSEMITE NATIONAL PARK
BRIDGEPORT
MINERAL CO
MADERA
FRESNO
INYO
INDEPENDENCE
Highest point in the UNITED STATES
Owens Lake
Lowest point in United States
Death Valley
NYE CO
TULARE
KERN
SAN BERNARDINO
LINCOLN CO
Las Vegas
Electric Power Lines
Railroads
Highroads
Post Offices
Other Places
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU - 1916


KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
BAKERSFIELD
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
Scale of miles
0 5 10 15 20 25 30

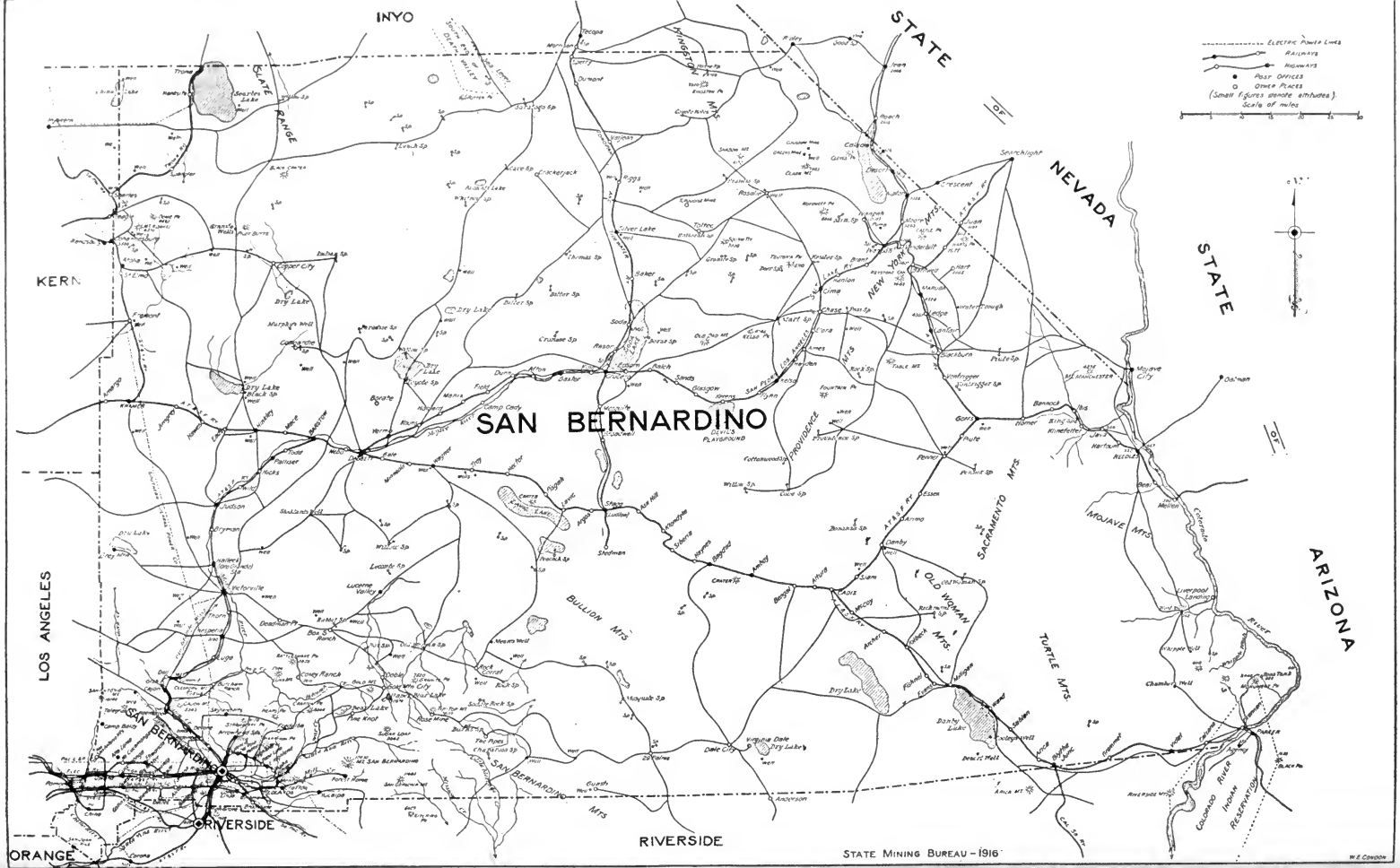


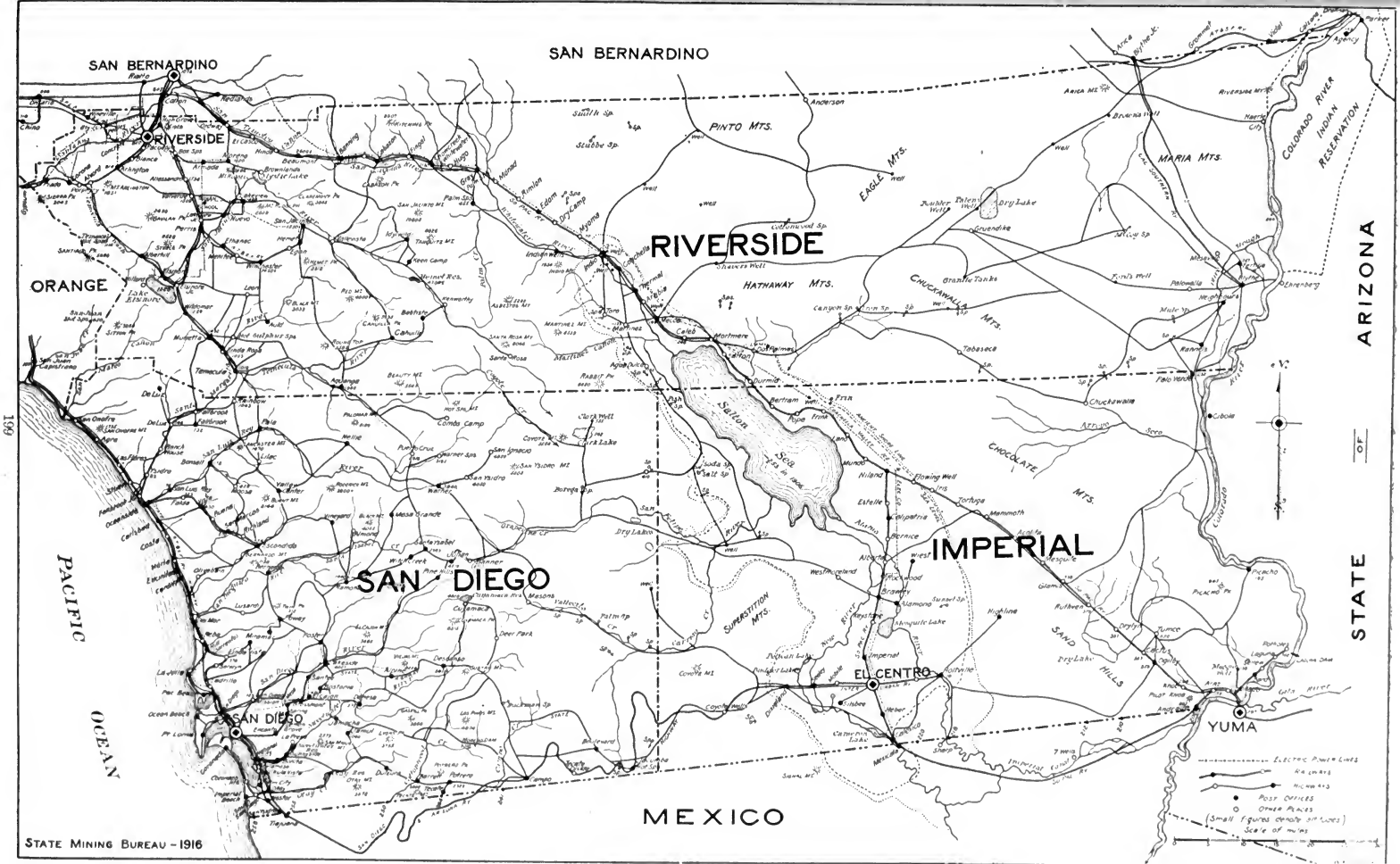
Electric Power Lines
Railways
Highways
Post Offices
Other Places
(Small figures denote altitudes)
Scale of miles.
MERCED
FRESNO
KINGS
KERN
SAN BENITO
MONTEREY
SANTA CLARA
SANTA CRUZ
SAN LUIS OBISPO
Monterey Bay
PACIFIC
OCEAN
HOLLISTER
SALINAS
King City
Soledad
Gonzales
Coalinga
Parkfield
Bradley
San Ardo
San Lucas
Jolon
Big Sur
Lucia
Gorda
Carmel
Pacific Grove
Monterey
Watsonville
San Juan Bautista
Castroville
Tres Pinos
Paicines
Idria
State Mining Bureau - 1916


KINGS
KERN
MONTEREY
VENTURA
SAN LUIS OBISPO
SAN LUIS OBISPO
SANTA BARBARA
SANTA BARBARA
PACIFIC
OCEAN
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
Scale of miles.
0 5 10 15 20 25 30



STATE MINING BUREAU - 1916


INYO
KERN
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
NEVADA
STATE
ARIZONA
SLATE RANGE
PROVIDENCE MTS.
SACRAMENTO MTS.
MOJAVE MTS.
BULLION MTS.
OLD WOMAN MTS.
TURTLE MTS.
NEW YORK MTS.
SAN BERNARDINO MTS.
COLORADO RIVER INDIAN RESERVATION
DEVILS PLAYGROUND
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes).
Scale of miles
STATE MINING BUREAU - 1916
W. E. CONDON


SAN BERNARDINO
SAN BERNARDINO
RIVERSIDE
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL
PACIFIC OCEAN
MEXICO
ARIZONA
STATE OF
PINTO MTS.
EAGLE MTS.
MARIA MTS.
COLORADO RIVER INDIAN RESERVATION
HATHAWAY MTS.
CHUCKAWALLA MTS.
CHOCOLATE MTS.
SUPERSTITION MTS.
SAND HILLS
Salton Sea
Salton Sea
EL CENTRO
YUMA
SAN DIEGO
STATE MINING BUREAU - 1916
Electric Power Lines
R.R. Lines
Highways
Post Offices
Other Places
(Small figures denote air lines)
Scale of miles

INDEX.

4598 10-20 5M